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ENVIRONMENTAL IMPACT EVALUATION

GREAT CREEK FLOOD CONTROL PROJECT

Milford, Connecticut

July 1984

Department of Environmental Protection

State of Connecticut

Department of Environmental Protection

State Office Building Hartford, Connecticut 06106

Stanley J. Pac

Commissioner

July 18, 1984

RE: Environmental Impact Evaluation
Great Creek Flood Control Project
Milford, Connecticut

Dear Reviewer:

The Department of Environmental Protection proposes to construct the project herein described to alleviate the chronic flooding conditions currently experienced in the lower Great Creek drainage basin in Milford, Connecticut. Pursuant to Section 22a-1a-7 of the Regulations of Connecticut State Agencies, this Environmental Impact Evaluation has been prepared and is being made available for public review and comment.

A detailed evaluation has been made of the proposed action, its probable impacts and alternative actions which might be employed to remedy the deficient conditions in the project area. The findings of that study along with a description of the project area are contained in this document.

Your review and comment on this project are actively encouraged. Written comments as well as any questions or requests for further information may be forwarded to Frederick Riese, Department of Environmental Protection, 71 Capitol Avenue, Hartford, Connecticut, 06106. The deadline for submission of comments is September 7, 1984.

Sincerely,

Stanley J. Pac

Stanley J. Pac

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SUMMARY

In response to continuing chronic flooding problems experienced by the residents of the lower Great Creek drainage basin in Milford, the General Assembly authorized funds through Special Act 83-17, Section 2(e)g, for the construction of drainage improvements in that watershed. These improvements will be financed in their entirety with State funds.

Great Creek drains a watershed of 504 acres in south central Milford. Residential development at high densities has taken place in the southern portions of the basin near beaches on the Long Island Sound shorefront. These structures are located at very low elevations on artificial fill placed in a former tidal wetland. The combination of these low elevations and poor drainage from the basin caused by undersized and frequently clogged outlet works produces frequent inundation of yards, streets and occasionally homes. Milford public works forces are also kept busy cleaning and maintaining the outlet channel which can become blocked by sand as often as thrice per week in the spring.

The firm of Diversified Technologies Corporation was retained by the State to develop and evaluate options to correct these flooding problems. Numerous plans, both structural and non-structural, were considered. The selection of an individual flood control strategy involved coordination with town officials, a public hearing to gather the input of the residents in the project area, and the continuous evaluation by the Department of Environmental Protection as the proposal evolved. This selection process yielded the proposal described in this report.

Increased protection from flooding for local residents will be accomplished by relocating and enlarging the discharge outlet from the basin. The existing outlet works will be replaced by a culvert of considerably larger capacity located at the eastern edge of the Silver Sands State Park beachfront. Discharge capacity will be increased from the existing 86 cubic feet per second (cfs) to 590 cfs. The new box culvert will run for 315 feet and will be 5' by 16' in cross-section. The existing outlet works, measuring only 48" in diameter at its outlet pipe, will be abandoned and plugged.

Regulation of incoming tidal flows will be maintained using two 72" x 54" self-regulating tide gates. Two manual sluice gates of the same dimensions will also be incorporated to serve as a back-up system and in the event of maintenance or repair of the tide gates. Both sets of gates will be located in a concrete vault built into the upstream end of the box culvert.

To direct the flows in Great Creek to this relocated outlet, 3,190 feet of new channel will be excavated. The main portion of this channel will intercept the East Branch of Great Creek,

bypass the existing confluence of the two branches, and deliver this flow to the West Branch. Small segments of the lower portion of the West Branch will also be rechannelized. The new confluence will be formed within the existing West Branch. From this point, the total creek flow will be diverted westward and then southward to the box culvert. The channel will average 30 feet in width above the new confluence and be 40 feet wide from that point to the culvert.

Upon outletting from the box culvert, the flow of Great Creek will cross Silver Beach and empty into Long Island Sound. Two timber-sheeted training walls will be erected on Silver Beach to confine the creek channel. These will be at a spacing of 18 feet and be located adjacent to the park property boundary.

Benefits from this project will accrue from several accounts. Foremost, of course, is the extra flood protection. Whereas at present, storms as frequent as the semi-annual event can overwhelm the ability of the existing outlet to release the flows and thereby cause neighborhood flooding, chronic flooding from such high-frequency, low-magnitude storms will be eliminated as a result of a sixfold increase in outlet discharge capacity with the new structure. For more significant storms, of the magnitude of the 10-year event or larger, drainage of excess waters impounded within the marsh will be accomplished much more rapidly than is presently possible. Thus, for the largest storms, the duration of flooding can be reduced from a period of several days to within one tidal cycle.

In addition to relief from flooding, the second major goal of the project is the restoration of the Great Creek marsh to a healthy, tidal salt marsh. This system has historically been characterized by regular tidal flushing and saltmarsh vegetation. Gradual degradation to its present state followed as a result of filling within the marsh and the near elimination of tidal flushing due to the existing undersized, frequently clogged culvert. The saltmarsh species died and were replaced by a monoculture of the reed <u>Phragmites</u>. Biologic diversity and productivity declined. Today the Great Creek marsh is a severely degraded ecological system.

The opportunity to restore and upgrade the marsh to its previous saltmarsh nature appears promising. The factors which will allow this improvement to be realized are the greatly enlarged culvert capacity and the inclusion of self-regulating tide gates. The self-regulating gates, unlike standard tide gates, allow for a two-way exchange of water between the marsh and the Sound. Therefore, the large volumes of saltwater required to sustain an active saltmarsh vegetative assemblage can be admitted upon each incoming tide. The resultant inundation of the marsh will lead to the gradual die-off of the invader species and their replacement by characteristic saline-dependent vegetation.

Reversion to salt marsh carries other pluses for the Great Creek area. Chief among these are substantial reductions in the potential for and intensity of marsh fires, a less favorable habitat for the breeding of mosquitos, and the improved aesthetics of a salt marsh.

Town public works expenses should be reduced as a result of the abandonment of the existing creek outlet. No longer will frequent visits by the town maintenance forces be necessary to open the blocked channel or pipe.

Finally, the reduced threat of flooding should provide an impetus for neighborhood improvements. The incentive for homeowners to upgrade their homes and properties will be enhanced. Both these improvements and the general reduction in the occurrence of flooding will foster increased property values. The grand list of Milford and the tax revenues realized by the city will eventually also reflect these benefits.

Short-term and long-term impacts will arise as a result of the implementation of this project. The short-term impacts include the noise, traffic and dust experienced in the project area during portions of the six month construction interval, exhaust emissions from construction equipment, the closing or partial closing of East Broadway to traffic during placement of the box culvert, and sedimentation in and from the basin. Following these construction impacts and the activition of the new channel and outlet, a gradual die-off of the reed growth in the marsh will produce floating debris which will be both unsightly and which may require extra maintenance to clean it from the gate structures.

The only long-term adverse impact meriting consideration is the commitment of an eighteen foot wide strip of State beach to permanent use for drainage. Approximately 360 square yards of beach area will be involved. Conversely, the abandonment of the existing outelt channel across Fort Trumbull Beach will add a similar amount of usable space to that private beach.

Revised cost figures for this project indicate a price tag of $717,000 (April 1984).

EIE Distribution List

Federal Agencies

- This document will be a part of the application to the U.S. Army Corps of Engineers for the required 404 permit and will be reviewed by that agency and other appropriate Federal agencies at that time.

State Agencies

- Office of Policy and Management
  Gary King, Comprehensive Planning Division
- Council on Environmental Quality
  Domenic Forcella, Executive Director
- Connecticut Historical Commission
  John Shannahan, State Historic Preservation Officer
- Department of Agriculture
  John Volk, Aquaculture Division
- Bureau of Public Works
  Morgan Ely, Design and Review
- Department of Environmental Protection
  William Miller, Parks and Recreation
  Paul Perlsweig, Solid Waste Management

Municipal Officials

Mayor - Alberta Jagoe
City Clerk - Margaret Egan
Conservation Commission Chairman - Bartley Block
Flood and Erosion Control Board Chairman - Edmund Colangelo
Director of Public Works - John Donnelly
City Engineer - John Casey
City Planner - Wade Pierce
Chief Environmental Officer - William Howard
Alderman - James Amann
Alderman - William Engle
Alderman - Nancy Murino

State Legislators

Thomas Scott - Senator, District 14
T.J. Casey - Representative, District 118

Organizations and Individuals

Dr. Murali Atluru, Diversified Technologies Corp., Inc.
Thomas Steinke, Fairfield Conservation Commission
William Ziebell, Silver Sands Association

Public Notices

Public notices announcing the availability fo this document have been published in the following media:

New Haven Register (7/26, 8/2, 8/9)
Milford Citizen (7/27, 8/3, 8/10)
Connecticut Law Journal (7/24)

INTRODUCTION

The Department of Environmental Protection has been directed to take corrective action to alleviate the chronic flooding conditions which occur in the lower reaches of the Great Creek watershed in Milford. Funding for this work has been provided by the Connecticut General Assembly through Special Act 83-17, Section 2(e)9. This project will be financed totally with State funds.

Great Creek drains a watershed of 504 acres in the south central part of Milford before emptying into Long Island Sound 1,900 feet to the east of Silver Sands State Park. The maximum dimensions of the watershed are approximately 7,000 feet north-south and 5,000 feet east to west. The boundaries of the watershed are shown in Figure 6. Residential development is the predominant land use accounting for almost 60% of the watershed. Open space, consisting mostly of the 105 acre Great Creek marsh, and the municipal landfill are the other major land uses. Thirty-three percent of the watershed is undeveloped.

Most of the Great Creek drainage basin lies at very low elevations. The highest point, 92 feet above mean sea level, is located at the northernmost point in the watershed near Tower Street. The lowest point occurs along the Long Island Sound shorefront. It is at the lower elevations that chronic flooding problems are experienced. Virtually all of the Great Creek marsh lies below elevation 5.0 feet with the majority of it being less than 3.0 feet above mean sea level. Around 1915 - 1930, fingers of fill were extended northward into the marsh from the barrier beach on which East Broadway is located. Although the barrier beach is at elevations which generally range from 8' to 9' above mean sea level, the fill was placed to elevations only marginally higher than the marsh itself. Numerous dwellings on small lots were constructed on these fill extensions. Today there are 260 affected homes in the project area located along the north side of East Broadway, the west side of Surf Avenue and the 13 dead end streets extending northward into the marsh off East Broadway between the state park and Surf Avenue. Because of their low elevation and the poor existing drainage from the Great Creek marsh system, many of these homes experience flooding on a semiannual or more frequent basis. The flooding consists of property inundation, submerged roadways, porch and storage area flooding and, for the more severe storms, water in the actual living spaces of dwellings. The problem is compounded by the exceedingly slow drainage from the basin which can extend the period of inundation to as much as three to five days.

The existing outlet structure for Great Creek consists of a 6' X 5' box culvert passing beneath East Broadway, a tide gate chamber, and a 48" diameter concrete pipe which outlets into an open channel across Fort Trumbull beach. Due to its deteriorated and non-functional condition, the wooden flapper-style tide gate has been permanently locked in an open position. Before this was done in 1977, the gate had locked itself into a semiclosed position due to sand and debris in the outlet. This had further reduced the poor drainage characteristics of the outlet and had totally eliminated any tidal flushing.

Even with the flapper gate locked open, the 48" concrete pipe and the channel into which it discharges still remain as serious constrictions to free drainage. Shifting sand frequently blocks the open channel. This sand comes from two sources. Littorally transported sand can be drawn up the channel as the tide rises and waters from the Sound enter Great Creek. The channel is also surrounded by beach sands built up to higher elevations which can either slough off or be blown into the channel. Once in the channel, some of this sand is invariably carried into and deposited in the pipe. The discharge flow from Great Creek has insufficient velocity to cleanse the outlet of this debris. The result is partial or occasionally total blockage of the pipe or channel which inhibits drainage and tidal interchange producing elevated water levels and stagnant conditions in the marsh. Town of Milford public works crews are frequently summoned to the area to remove sand blockages in the channel, as often as two or three times per week in the spring.

Alleviation of the flooding problems at Great Creek has been the subject of several studies done since the early 1970's. In addition, many of the evaluation concerning the closure of the Milford landfill and the development of Silver Sands State Park have also considered the impacts of these plans upon the drainage of the Great Creek watershed. As presently proposed, closure of the landfill in a manner which will prepare it for park development will add 34 acres to the Great Creek drainage basin, enlarging it to 538 acres. This will increase by approximately 6.7% the volume of incident precipitation and eventual runoff that must be stored in the marsh and discharged through the outlet. Park development will further increase runoff by adding to the area of impervious surfaces in the basin. For this reason, it is imperative that relief measures be undertaken before the landfill is closed and the park developed. This necessity is recognized by Special Act 83-17 which specifically links the flood control project to the landfill closure by providing a combined authorization of $6,500,000 for the two projects.

LOCATION OF PROJECT

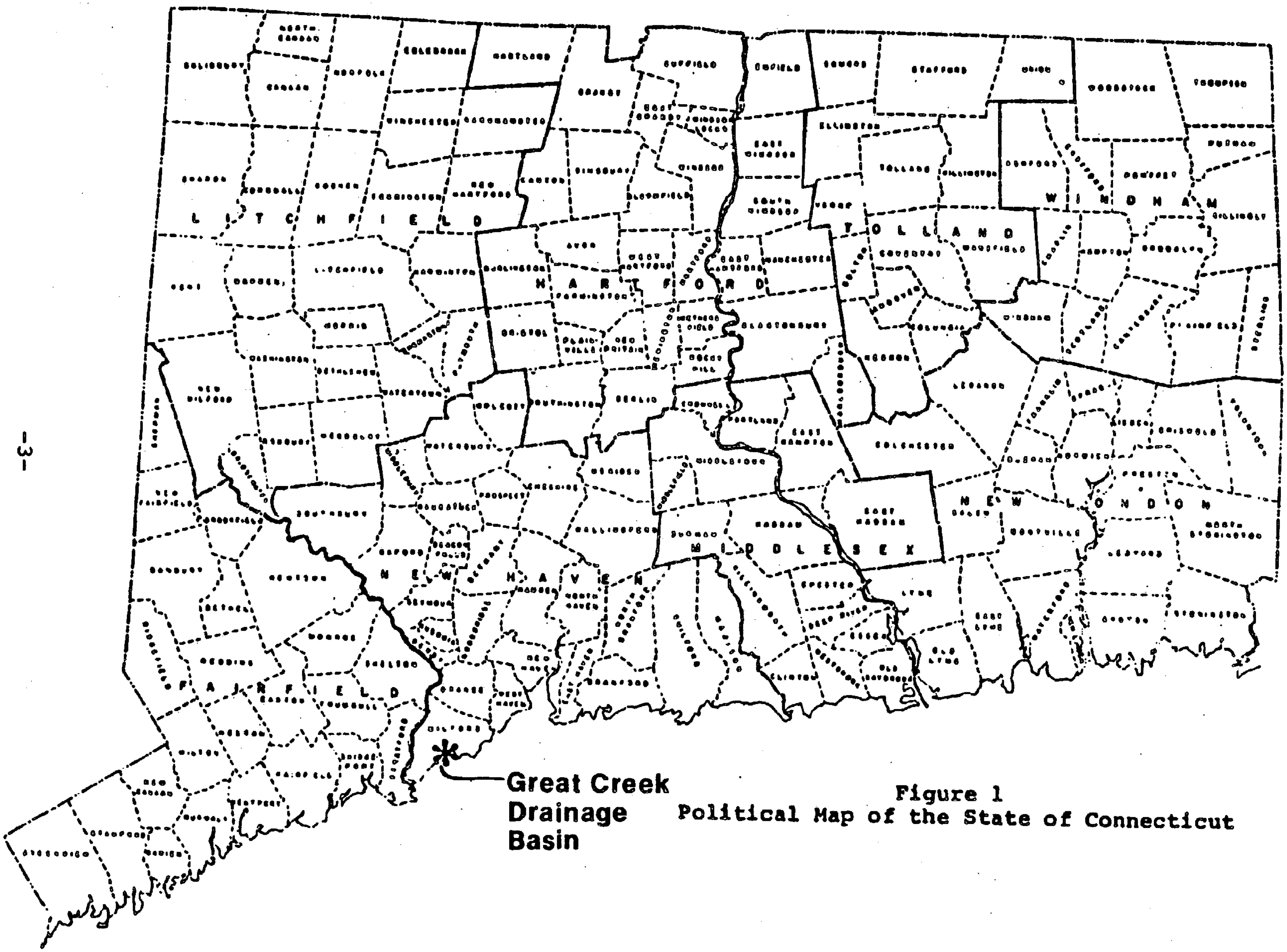

Figure 1
Political Map of the State of Connecticut

PROJECT SETTING

The immediate project area consists of the 105 acre Great Creek marsh and the barrier beach which separates it from Long Island Sound. This marsh is the remaining portion of a previously extensive tidal marsh system known as the Meadows End Marsh. As shown in Figure 2, an 1837 U.S. Geological Survey map, the Meadows End Marsh included all of the area between the present locations of Nettleton and Surf Avenues and was fronted by a barrier beach broken only by the outlets of Great Creek and Fletchers Creek. Under the then-existing natural conditions, sufficient tidal flushing was available to maintain the whole marsh as a healthy, functional tidal marsh ecosystem.

Gradually the area was developed resulting in the loss of most of the marsh, the degradation of the remaining area and the evolution of the present hydrologic conditions. East Broadway was constructed atop the barrier beach. Following this, much filling of the marsh behind the beach was done over the entire length of this stretch. Homes were constructed both along the barrier beach and on the newly placed fill. The establishment and gradual expansion of the Milford Landfill consumed most of the remaining wetlands in the western half of the marsh and eliminated much of the length of Fletchers Creek.

Substantial alterations subsequent to the establishment of the landfill in the late 1940's include the destruction of the summer homes and cottages south of the landfill by Hurricane Diane in 1955 and the construction of the East-West Service Road in the early 1970's. At various times between the early 1950's and 1972, the sewage treatment plant, pump station, dog pound and refuse shredder were built on landfilled marsh. Following the destruction by Hurricane Diane, the State of Connecticut acquired those cottage sites along East Broadway west of the pump station, together with adjoining interior properties, to form Silver Sands State Park.

Extent of Existing Flooding Conditions

There are 260 affected homes in the project area.[1] These are located along the north side of East Broadway, the west side of Surf Avenue and on Pearl, Cooper, Hanover, Chetwood, James, Gardner, Silver, Blair, Tremont, Maddox, Scott, Caroline and Pleasant Streets, all of which run north off of East Broadway (See figure 3). Although East Broadway and Surf Avenue run at elevations which generally exceed seven feet (MSL), the thirteen side streets off East Broadway are mostly at elevations below 5.0 feet as is the extreme southern portion of Surf Avenue.

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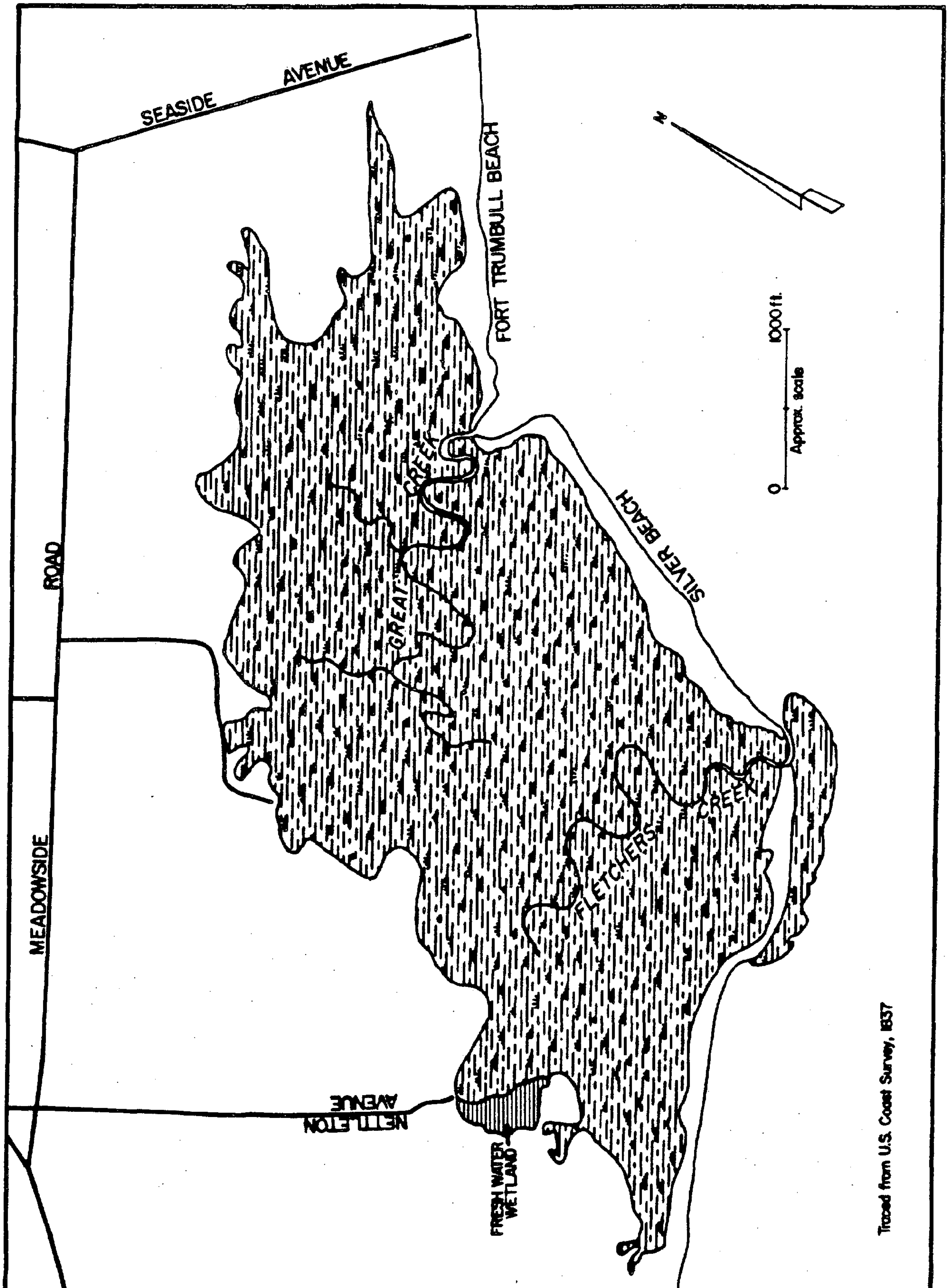
[1]Diversified Technologies Corporation, Pre-Design Report, Flood Control-Great Creek Silver Sands State Park, Milford, CT, 1983, p. 91.

MEADOWS END MARSH, 1837

FIGURE 2



GREAT CREEK PROJECT AREA (Including planned improvements) FIG.

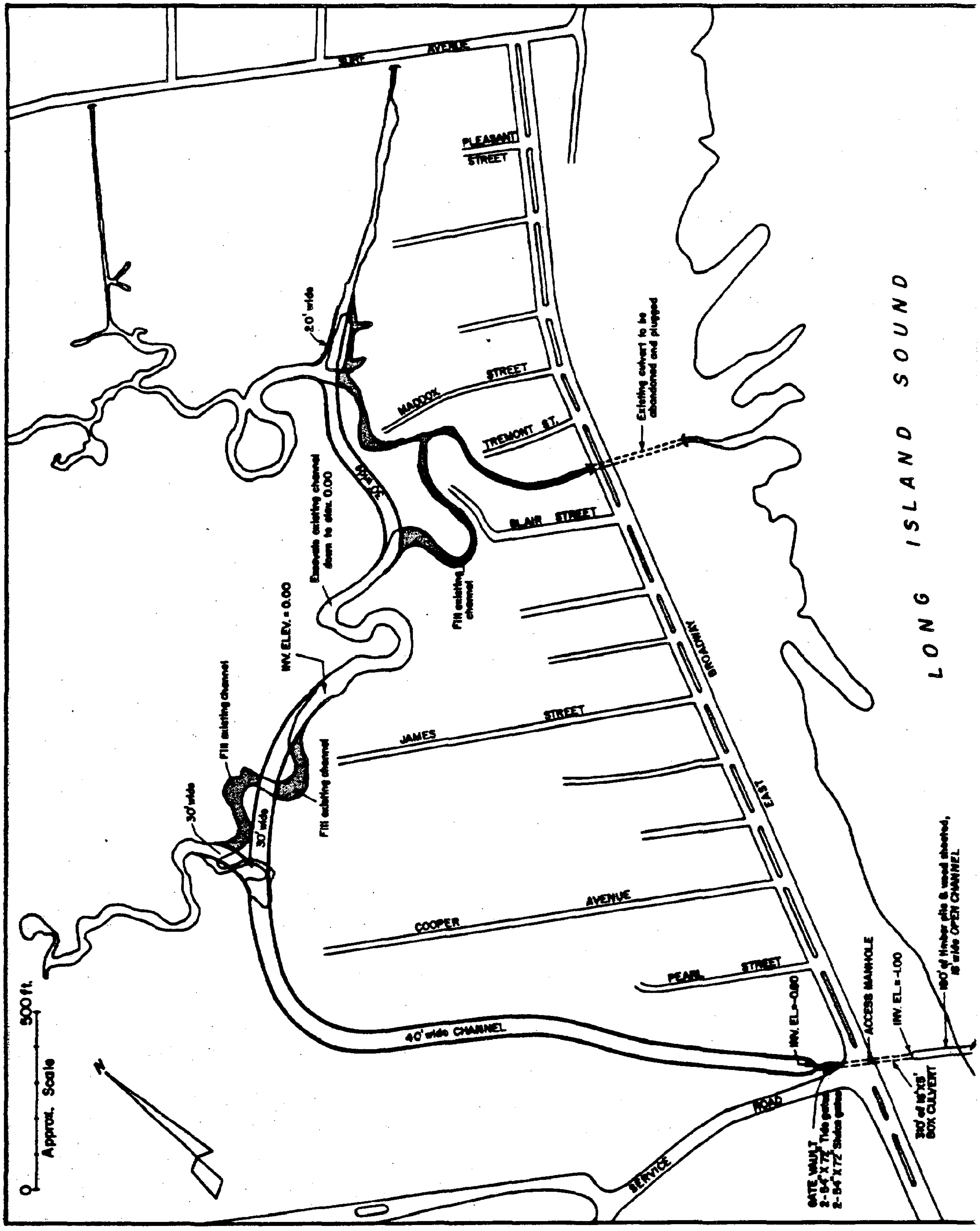


Table 1 shows the elevations of the 260 homes in the project area. Almost two-thirds of these homes are located within the 5 foot elevation contour. This means that these homes are surrounded with water even in a comparatively minor flooding episode. Such minor, high frequency events also inundate the neighborhood streets listed above.

Flooding of the actual living space of dwellings is not as common. As shown in Table 1, only seven homes have sill elevations below 5.0 feet (MSL). Only nine are below 5.1'. Yet a considerable number of homes in the East Broadway neighborhood have experienced floodwaters in their first floor living areas in the more substantial storms.

Table 1[2]

ELEVATIONS OF 260 HOMES

	Sill Elevation # of homes	Contour Elevation # of homes
Below Elevation 4.0	0	41
Between 4.0 and 5.0	7	127
Above Elevation 5.0	253	92

Data on the frequency at which flooding of various magnitudes occurs is presented in the following subsection. These flood elevations result from the combination of the given precipitation event and the hydraulic or drainage characteristics of the basin. It is the latter factor which produces the chronic flooding problems peculiar to the lower Great Creek basin. More specifically, the outlet from the Great Creek marsh is deficient in capacity and constricts flow severely enough to produce the flood elevations which inflict hardship on area residents.

In a drainage study of Great Creek done for DEP in 1974, C.E. Maguire[3] listed the following two factors as contributing to the drainage problem in the lower reaches of Great Creek.

"1. The outlet of Great Creek into Long Island Sound is vulnerable to sanding in by littoral currents of the Sound. This greatly reduces the discharge capacity of storm runoff from the watershed. The partial blockage of the outlet reduces flow velocities in the culverts and brook channel, which in turn leads to settling out of suspended particles (silting) carried by the storm runoff, reducing the discharge capacity of the drainage installations even more.

[2] Ibid., p. 91.

[3] C.E. Maguire, Drainage Study, Great Creek, Silver Sands State Park, Milford, Connecticut, September 1974, p. 12.

2. A conglomerate of box culverts, tide gates, junction boxes and round concrete pipes presently in existence between the inlet to the 6' x 5' box culvert and the outlet pipe at the sound, causes very high friction losses (i.e., has poor hydraulic characteristics)."

The problem of the maintenance of the channel was again discussed in a 1978 report by C.E. Maguire.

> "The level of the sand on the shore of the Long Island Sound adjacent to the outlet of the 48" pipe (Great Creek outlet) is several feet above the top of the pipe. An outlet channel from this pipe end toward the Long Island Sound is being maintained by Town forces by means of a front end loader which is brought there after those storms whose wind direction and accompanying high tide inundate the outlet. Wave action from those storms has a leveling effect on the sea shore and fills the manmade depression maintained in the shape of a channel and the depressed outlet pipe. The velocity head of the Great Creek flow is generally insufficient to force the sand away from the outlet. Under these conditions, the outlet pipe is then closed and buried with several feet of the shifting sands."[4]

The following photos, also from the 1978 C.E. Maguire report, show the existing channel as it outlets from the 48" culvert and as it crosses the beach.

Thus, the existing problem can be, in very large part, attributed to an outlet works which is undersized and is designed in such a way as to produce high hydraulic friction losses and to the channel infilling problems which further reduce the hydraulic capacity of the outlet and which require frequent maintenance.

Flood Elevations and Frequency

Having discussed the manmade factors which contribute to the flooding at Great Creek, i.e. the deficiencies of the existing outlet structures, let us now look at the natural inputs upon which the drainage system is superimposed. These factors include the runoff characteristics of the basin, the tidal regime in Long Island Sound, and the storm events, either coastal, inland, or a combination thereof, which supply the basic ingredient of a flood, which is water.

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[4] C.E. Maguire, Drainage Study, Great Creek, Milford, Connecticut, March 1978, p. 4.

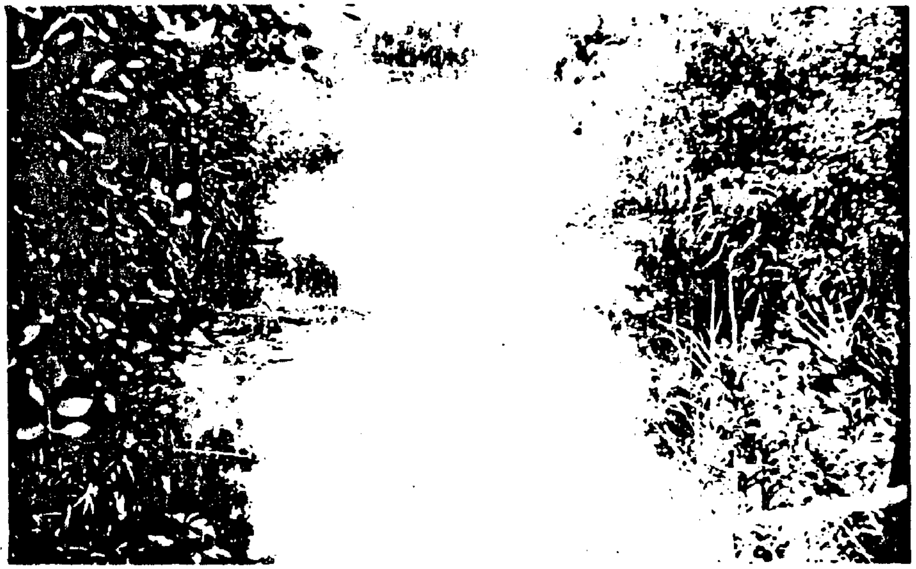
(A)

Outlet of Great Creek into Long Island
Scund at Low Tide

(B)

(C)

Great Creek Tidal Flood Plain During
Low Tide and Zero Storm Runoff Retention



(H) Tributary To Great Creek

(I) Tributary to Great Creek

(J) Tributary to Great Creek

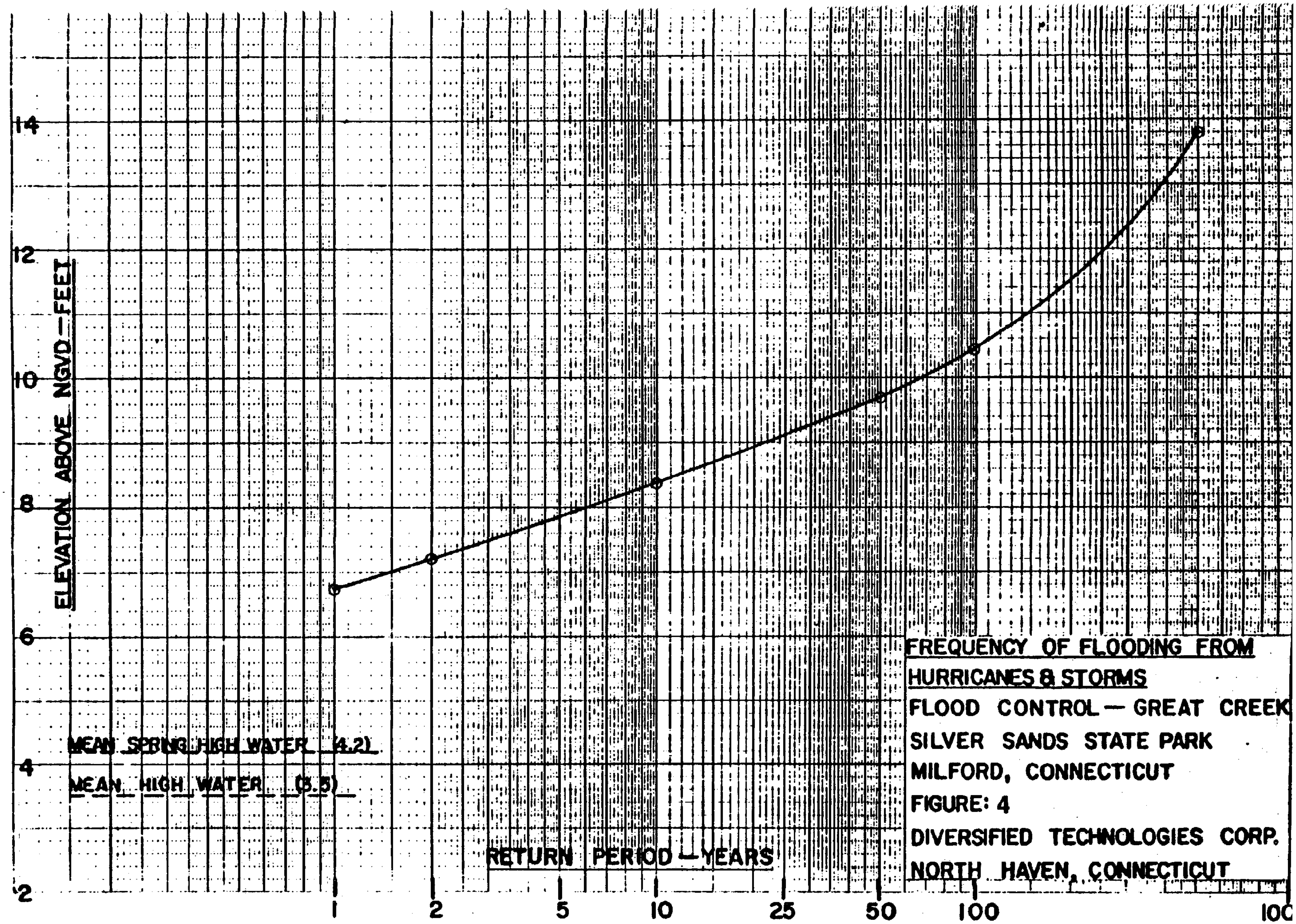
The Great Creek basin can be divided into two subbasins each of which is drained by one of the two branches of the creek. The East Branch drains the greater fraction, 292 acres or 58% of the watershed including the northernmost portions extending to Tower Street and areas as far east as Seaside Avenue. The West Branch drains 209 acres or 41% of the watershed including the eastern portions of the landfill property. It is the West Branch that will receive runoff from an additional 34 acres of the landfill site following its closure. The final 4 acres or approximately 1% of the drainage basin lies below the confluence of the two branches.

Analysis of the runoff characteristics of both branches shows greater runoff and faster collection from the more heavily developed eastern sub-basin. Runoff coefficients for the two branches computed as per ASCE Manual 37 are 0.52 for the East Branch and 0.38 for the West Branch. The times of concentration for the East and West Branches are 46.4 minutes and 82.6 minutes, respectively.

The East Broadway residential neighborhood is vulnerable to flooding from both coastal and inland events. These events are often coincident, especially for the larger storms including hurricanes, although this is not necessarily so. In addition to the possible superimposition of coastal and inland events, the tidal cycle also exerts an additive effect on water levels experienced along East Broadway and within the Great Creek marsh. This is true both for storm surges imposed on high tides and for interior drainage from the marsh as it is impeded by elevated water levels in the Sound.

From the coastal side, the elevation of the floodwaters produced by storms of various frequencies is given in Figure 4. As this figure also shows, for the Silver Sands area, mean high water is 3.5' MSL with the mean spring high tide at 4.2'. Spring high tide is experienced twice daily for approximately three days out of each month. From this point, the level of high tide grades back to mean high tide in approximately a week and then falls to its lowest point about two weeks after the spring tide. Of course, the tidal levels actually experienced on any given day may deviate greatly from the normal values as they are influenced by wind or storm conditions or even by storms far out at sea.

The shorefront along East Broadway is subjected to storm driven waters reaching elevation 6.75' above mean sea level approximately once per year. Following the curve plotted in Figure 4, the two year storm can be expected to produce waters to elevation 7.2'. Once every ten years, on the average, floodwaters to 8.4' are generated by a coastal storm or hurricane. This particular frequency storm is very important because it is at this elevation that coastal waters will overtop East Broadway and flow overland into Great Creek. Figure 4 also shows that the storms which can be expected to recur at 50, 100 and 500 year intervals will generate floodwaters to 9.7', 10.4' and 13.8', respectively.



FREQUENCY OF FLOODING FROM HURRICANES & STORMS
FLOOD CONTROL — GREAT CREEK
SILVER SANDS STATE PARK
MILFORD, CONNECTICUT
FIGURE: 4
DIVERSIFIED TECHNOLOGIES CORP.
NORTH HAVEN, CONNECTICUT

For storms which generate storm tides of less than approximately 8 feet, the barrier beach along East Broadway acts as a protective dike for the homes north of it. The existing channel and constricted outlet prohibit elevated water levels in the Sound from being transmitted into the Great Creek marsh and causing flooding there. Thus, the same feature which has reduced tidal flushing and caused marsh degradation has also served a beneficial function in protecting the marsh-adjacent homes from the transmission of elevated Sound-side water levels into the marsh.

As mentioned above, storms which produce tidal flooding elevations in excess of 8 feet will overtop the East Broadway barrier beach. Storms of this magnitude will occur at a frequency of once per decade over the long term. East Broadway itself is at elevations of between 7.0 feet and 8.0 feet throughout the project area except at the extreme eastern end where it drops to 6.5 feet at its junction with Surf Avenue. North of East Broadway, the barrier beach drops off in elevation fairly quickly. It is to the south where the maximum elevations are attained. The homes along the south side of East Broadway are constructed on the highest strip of the beach. The crest of this beach reaches its minimum elevation of just over 8 feet at Pearl Street on the west end and at Blair Street, the first street to the west of the existing outlet. Most of the beach tops out between 8 feet and 10 feet above MSL. The highest points occur toward the eastern end between Tremont and Pleasant Streets. Here the crest is above 10 feet, reaching 11.3 feet at Maddox Avenue.

The height of the beach sets the effective maximum level of flood protection which can be provided from coastal storms. In order to increase the height of the beach, several very expensive and/or socially unacceptable steps would need to be taken. These would include either acquisition and removal of some structures along East Broadway or structural modifications and partial burial in order to strengthen and floodproof the homes and raise the berm elevation between the houses.

In contrast to coastal flooding in which precipitation plays a very minor role, inland flooding is the result of individual or collective precipitation events. Inland flooding results when incident precipitation in the basin produces runoff at rates which exceed the discharge capacity of the existing outlet. With the existing outlet, overtopping of the Great Creek channel begins with any flow exceeding 77 cubic feet per second (cfs). Diversified Technologies calculated that, with flooding in the basin to elevation 5.0 feet, the discharge through the outlet is only 86 cfs.[5]

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[5]Diversified Technologies Corporation, Pre-Design Report, Flood Control-Great Creek, Silver Sands State Park, Milford, CT, 1980, p. 48.

Comparing these discharge capacity rates to the flows produced by several design storms, it becomes apparent that the inland flooding problem is, for the most part, a result of the inadequacies of the existing outlet. Referring to Table 2, we find the calculated discharge rates for storms of 2, 5, 10, 25, 50 and 100 year recurrence intervals to be 224, 300, 353, 423, 478 and 531 cfs, respectively, under existing conditions.[6] With the closure of the Silver Sands landfill and the development of Silver Sands State Park, an additional 34 acres will be added to the Great Creek drainage basin. This will increase the six calculated design flows to 249, 333, 393, 470, 531 and 590 cfs, respectively. These numbers clearly show the imbalance between inflow and discharge under storm conditions with the existing provisions for drainage.

It must be pointed out that some of this excess water can be safely stored in the marsh basin before it rises to flood-producing levels. Up to 96 acre-feet of storage is available in the basin below elevation 4.2'. This available storage is consumed as the tide rises, diminishing to 0.0 acre-feet if the mean spring high water level is attained. Therefore, depending on tidal stage, a storage volume of up to 96 acre-feet may be available in the basin below elevation 4.2'. When completely drained, at low tide, this storage volume represents approximately 60% of the runoff volume of the two year storm, 50% of the ten year runoff or 40% of the centennial flow volume. The severity of inundation and damage increases geometrically as the water level rises above this point but, of course, the frequency of the greater events decreases geometrically. Table 3 gives the precipitation in inches, the runoff volumes produced and the resulting flood stages assuming total in-basin storage of those volumes for the 2, 5, 10, 25, 50 and 100 year storms.

Beach Dynamics

The Great Creek marsh system is separated from Long Island Sound by a narrow barrier beach. Due to the protection afforded this area by Welches Point and Gulf Beach to the east and by Charles Island and its connecting tombolo to the west, Fort Trumbull Beach and Silver Beach are relatively stable portions of the Milford shorefront. The major cause of erosion along these beaches is storm-generated waves. Tidal currents here are generally too weak to suspend and remove sediments.

Fort Trumbull and Silver Beaches lie at the northern end of a small protected bay known locally as 'The Gulf.' This roughly square-shaped body of water occupies slightly more than one square mile. On its western side, a 3,000 foot tombolo provides a tenuous linkage between Charles Island and the mainland and is

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[6] DTC, p. 37.

TABLE 2

		STORM DISCHARGES--cubic feet per second											
		East Branch		West Branch				a.East & West Branch					
		292.5 acres	225.0 acres	b 209.5 acres	c 242.1 acres	b 134.1 acres	c 196.4 acres	b 502.0 acres	c 534.6 acres	b 359.1 acres	c 421.4 acres		
% chance	Freq. years	Without Diversion	With Diversion	Without Diversion		With Diversion		Without Diversion		With Diversion			
50	2	213	172	77	101	46	79	224	249	163	199		
20	5	289	235	103	135	61	106	300	333	218	268		
10	10	342	275	122	159	72	124	353	393	256	315		
4	25	403	321	146	191	87	150	423	470	310	380		
2	50	456	365	165	215	97	169	478	531	348	426		
1	100	510	402	183	239	108	188	531	590	387	475		

a. cfs values computed treating the entire drainage area as a single unit.
b. Without Landfill Closure and Park development south of Service Road.
c. With Landfill Closure and Park development south of Service Road.

Source: Diversified Technologies Corporation, Pre-Design Report, Flood Control - Great Creek, Silver Sands State Park, Milford, CT, November 1983, p. 37.

RUNOFF, STORAGE, AND FLOOD STAGE FOR VARIOUS STORMS

FLOOD CONTROL-GREAT CREEK

TABLE 3

Stillwater Flood Elevation for Existing Conditions (502.0 acres)
(Total Storage in Great Creek Basin)

% chance	Freq. years	24 hour precip. inches	Volume of Runoff c = 0.46' Ac-ft.	Storage with water @ elev 4.2 (MSHW**) Ac-ft.	Total Storage Ac-ft.	Flooding Stage (NGVD)
50	2	3.3	63.5	96	160	4.82
20	5	4.3	82.8	96	179	5.00
10	10	5.0	96.2	96	192	5.10
4	25	5.7	109.7	96	206	5.24
2	50	6.3	121.2	96	217	5.33
1	100	7.2	138.6	96	235	5.47

** MEAN SPRING HIGH WATER

Note: Table assumes pre-storm water level in marsh at 4.2 feet. Thus, all internal storage volume below this elevation is consumed before storm. Total storage (column 6) equals storm runoff contained in the marsh basin plus tidal storage at mean spring high water.

Source: Diversified Technologies Corporation, Pre-Design Report, Flood Control - Great Creek, Silver Sands State Park, Milford, CT, November 1983, p. 50.

composed of material eroded from both. The landward end consists mainly of medium sand. Toward the seaward or island end, the tombolo grades into a mixture of more gravelly materials and boulders eroded from the island. Low tide exposes the tombolo while at high tide it is submerged. This feature appears to be stable or at least in dynamic equilibrium since 1929.[7]

Charles Island also operates to protect The Gulf and its beaches from westerly waves and storms. Charles Island appears to be an offshore expression of a till ridge whose mainland extension appears across Milford Gulf. The island is surrounded by a lag concentrate of gravel and boulders left behind as the fine material was eroded away. This lag concentrate acts as an impact absorber to protect and stabilize the island.[8]

West of the tombolo, longshore currents have heavily eroded the beaches removing much of the finer materials. Erosional rates of up to 3 feet per year were experienced until most of the beach material was removed.

On the eastern side of The Gulf we find a wide beach and a depositional environment at the northern end of Gulf Beach gradually grading into an erosional area of thinning beach as one heads south toward Welches Point. Widths of 100' to 200' are found at the northern end while to the south the beach has slimmed to 20-30 feet, becoming less sandy as one progresses. Approaching Welches Point, the beach is nearly all stones. This natural stone armoring, assisted in some areas by some dumped boulders and old timber lagging and by well-established vegetation, has kept the beach stable. Welches Point itself is protected by granite and mortar slope paving, steel sheet piling, a dumped boulder revetment and three granite block spur groins of approximately 100 feet in length. These have been sufficient to hold the point against any losses.

Along the northern perimeter of The Gulf, we find a generally healthy beach. Traveling eastward from the tombolo across Silver Beach, the beach widens to approximately 130 feet at the eastern boundary of the State property and maintains a 75 to 100 foot width above mean high water across Silver Beach. Texture is slope dependent with very fine sands in the flat intertidal area, fine to coarse sand above M.H.W. and some gravel or even small stones in the steepest portions of the beach.

Proceeding eastward, the present Great Creek outlet crosses the beach in a depressed channel slightly below the prevailing beach grade. Across Great Creek, Fort Trumbull Beach widens out

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[7] C.E. Maguire, Silver Sands State Park, Proposed Dredge Project Environmental Assessment Statement (DRAFT), August 1973, p. II-2.

[8] Ibid., p. II-2.

to 150 feet. This wide, healthy beach extends eastward to Burns Point and the entrance to Milford Harbor and Gulf Pond.

Waves are the major erosional force acting upon the beach in the project area. The size and power of the waves is determined by the strength, fetch and duration of the winds driving them. U.S. Weather Bureau records from New York City give the following data on wind direction in western Long Island Sound.

Originating Wind Direction	Percent of Total Wind Activity
North	14
Northeast	5
East	5
Southeast	5
South	13
Southwest	14
West	15
Northwest	29
	100

Of these wind directions, those from the W, NW, N and NE blow offshore and, therefore, do not generate waves affecting Connecticut beaches. Easterly and southwesterly winds have fetches of only 2.5 and 3 nautical miles, respectively, at the project area and thus do not produce waves as large as the S and SE winds which can blow unrestricted for distances of 12 and 22 nautical miles, respectively. Although the southerly winds are the more frequent (13% of total wind activity), the greater fetch to the southeast has produced the most destructive storms affecting this area.

Tidal currents in the study area are not strong enough to erode beach sediments but can transport sediment once it has been lifted into suspension by waves or other disturbances. Jacobsen found that The Gulf was an area of complex current patterns which are influenced by winds, especially those from a southerly direction. Despite this complexity, a general clockwise circulation pattern was found to exist in the area. Maximum recorded current velocities during the Jacobsen study did not exceed 0.6 feet per second. The Gulf was noted as an area of relatively stable shoreline due to the protection afforded by Charles Island, the tombolo and Welches Point.[9]

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[9] Nathan L. Jacobsen and Associates, Study of Shoreline Erosion and Shore Protection, Milford, Connecticut, 1981, p. V-4.

Flora and Fauna

The project environment for the Great Creek drainage improvements occupies two distinct ecological settings. Most of the work will occur within the Great Creek marsh. The remainder of the project, namely the open outlet channel and its timber training walls, will cross a sandy beach. Beyond the point of the physical termination of the project at the end of the training walls, the discharge flow from the creek will cross an area of sand flats and finally enter the waters of Long Island Sound. Each of these areas is discussed below in terms of the plant and animal species for which they provide habitat.

--Great Creek Marsh--

The Great Creek marsh system consists of approximately 105 acres of formerly tidal wetlands. Due to restrictions on tidal interchange and on freshwater drainage out of the marsh, these wetlands have lost their salt marsh characteristics and been converted to freshwater wetlands. The constricted drainage has also operated to produce an elevated water table within the system which has retarded the growth and vigor of the freshwater vegetation. Today, the Great Creek system is dominated by freshwater species and is mapped and regulated as designated inland wetalnds.

One small zone of diminished saline influence yet remains, however, at the confluence of the two branches of Great Creek. This area, being closest to the outlet, receives the maximum amount of saltwater influx and the lowest level of dilution. Yet even at this station, the salt marsh grass Spartina is confined to a narrow fringe along the creek and is generally overshadowed by Phragmites. Due to its inadequate capacity, clogging problems and malfunctioning tide gate, the present culvert simply cannot transmit sufficient volumes of saltwater to support saline-dependent species in the marsh.

An ecological study of the Great Creek marsh was performed in early 1983 preparatory to the development of the selected flood control plan.[10] The major wetland units identified are an extensive Phragmites marsh occupying much of the Great Creek area and a series of freshwater wetlands (marsh, swamp, pond, and stream types) along the northern and western boundaries of the park. Phragmites australis is the dominant vegetative species throughout the marsh and defines the character of the area.

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[10] Dr. Karl Eric Tolonen, Final Environmental Report, Great Creek Flood Control Project, Silver Sands State Park, Milford, Connecticut, Diversified Technologies Corporation, June 1983.

Appendix C contains a listing of all the species of vascular vegetation, aquatic organisms and birds identified in the Tolonen study as well as maps of the sampling locations.

Though it is not as productive as *Spartina* in terms of biomass generated, nutrient recycling or habitat value, it does provide some useful habitat functions.

The freshwater wetlands along the northern and western boundaries of the park contain a diversity of wetland plants, many of them of considerable value to wildlife. Such genera, noted at sampling stations M3-V, M5-V and M6-V (See figure 1 of Appendix C) include *Acer*, *Alnus*, *Cornus*, *Elaeagnus*, *Lindera*, *Quercus*, *Rhus*, *Sambucus*, *Toxicodendron* and *Viburnum*. Most of the birds using or sighted in the park (See Table 17 of Appendix C) have been seen in these freshwater areas. Among these is the Northern Harrier or Marsh Hawk (*Circus cyaneus*) which is a rare and endangered species in Connecticut.

Three other distinct environments are represented within the marsh. These are the pure *Phragmites* stands, the open water of Great Creek and a small area of mixosaline nature in the lowest reaches of the creek.

The *Phragmites* stands are almost a complete monoculture with virtually all other species having been eliminated. The *Phragmites* growth is at such a density as to render it nearly impenetrable. The tidal range within the marsh is so small, approximately 18 inches, that this area is not covered. Under the present conditions, the area will continue to be dominated by this species. Although *Phragmites* is of limited value to wildlife, during the 1983 ecological survey, a muskrat was seen eating the young stems and leaves of this reed. It also does provide cover for birds and small mammals.

The channel of Great Creek serves as both open water environment and an extension of the saline conditions of Long Island Sound. Sightings of Kingfisher, Mallard, Green Heron and Greater Yellowlegs were made on the park's open bodies of water such as Great Creek. Estuarine species such as horseshoe crab (*Limulus polyphemus*) and blue crab (*Callinectes sapidus*) enter the lower reaches of the creek, usually on the incoming tide.

The presence of *Spartina alterniflora* and other saline dependent species in the mixosaline environment in the lower reaches of Great Creek is an encouraging sign with regard to the restoration potential of the system. The survival of these species despite the restricted saltwater interchange shows both the ability and the availability of these estuarine species to recolonize any new salt marsh habitat created by increased tidal flushing.

In general, the diversity and productivity of the Great Creek marsh is low, especially when compared to local healthy salt marsh systems such as Nells Island which supports a wide range of avian and other species. It appears promising that the Great Creek system can be upgraded in quality and diversity, perhaps to the level it has previously experienced.

--Beach and Marine Environment--

Upon leaving the marsh, Great Creek passes beneath East Broadway and crosses a stretch of healthy beach and intertidal sand flats before entering The Gulf. The outlet is the dividing line between the shorefront areas known as Silver Beach and Fort Trumbull Beach, to the west and east, respectively.

Silver Beach and Fort Trumbull Beach are wide sandy beaches, heavily used for recreation and generally devoid of any life. Beaches in this area have historically been known to support beach needle grass (Aristada tuberculosa), a state rare species which prefers dry sandy sites along the coast. This species does not currently exist on either of these two beaches and the heavy recreational use makes its future establishment there unlikely.

The sand flats in the project area were not sampled specifically but can be assumed to contain species commonly associated with this habitat type. Due to substrate instability and to the lack of any large rocks or fixed surfaces, algae, epifaunal, and sessilebenthic species are absent. Species likely in residence here include hardshell, softshell and razor clams (Mercenaria mercenaria, Mya arenaria and Ensis directus, respectively) and various marine worms, notably polychaetes.

The Gulf supports a wide range of finfish, shellfish and crustaceans. Shellfish are harvested both commercially and for recreation. Quahogs (Mercenaria mercenaria), the most important recreational species, are taken from both intertidal and subtidal areas in sizes ranging from cherrystone up to four inches. The area is presently closed to recreational shellfishing due to bacterial pollution, nevertheless clamming does occur.

Eastern oyster (Crassostrea virginica) is the important commercial species. Again, due to bacterial pollution, local oyster grounds are closed to the harvesting of market sized oysters. Seed oysters, however, are removed from these beds for replanting in clean growing areas. Figure 5 shows both the commercially leased oyster beds and shellfish concentration areas. The latter, designated by the U.S. Department of Interior, Federal Water Pollution Control Administration in the State of Connecticut Shellfish Atlas (1970) are areas believed to support and produce shellfish of commercial and sport fisheries value.

A study of finfish and epifaunal invertebrates in The Gulf was made by Pellegrino and Baker in September of 1979.[11] Specimen were collected with a 30 foot otter trawl at stations east of Charles Island. A total of 14 finfish species were identified

[11] Pellegrino, P.E. and Baker, J.E., Environmental Monitoring Program of Shellfish Beds Off Charles Island (Milford): Demersal Finfish Communities, September 1979. Unpublished.

FIGURE 5

LOCATIONS OF LEASED OYSTER BEDS AND SHELLFISH CONCENTRATION AREAS

with a like number of bottom dwelling invertebrates. These are listed in tables 4 and 5, respectively. Of the finfish, winter flounder (Pseudopleuronectes americanus) accounted for 38.5% of the catch while porgies (Stenotomas chrysops) totalled 38.4%. Winter flounder is an important species for recreational fishing in the Charles Island area. Lady crab (Ovalipes oscellatus) was the most numerous of the epifaunal species collected. Most of the collection area was covered by a sand-shell bottom.

Development of Silver Sands State Park

Following the destruction of many of the shorefront homes along Silver and Myrtle Beaches by Hurricane Diane in 1955, the State of Connecticut began to buy up much of the coastal property for the eventual purpose of a coastal state park. By 1960, the first master plan for this park had already been formulated. Subsequent plans have been developed for the landfill closure, park roadway system, park drainage and the design of various buildings within the park.

Silver Sands State Park will offer 3,000 feet of beach frontage and 223 acres of parkland with parking capacity for 3,000 cars.[12] Facilities will include, in addition to the beach and parking areas, two concession stands with bathhouses, rest rooms, a boardwalk, dunes, a park headquarters building, a maintenance building, and a new access road. The Great Creek wetland will be left in an undeveloped state to serve as a passive nature study and wildlife area.

As the main element of the landfill closure plan, an estimated 930,000 cubic yards of fill will be either trucked on-site, hydraulically placed or some combination of the two. This fill will be used to cap the landfill and to leave a final surface grade suitable for the ultimate development of the state park. Based on the final contours currently envisioned for the landfill closure, approximately 34 acres of the landfill will be removed from the Fletchers Creek[13] and Nettleton Avenue channel drainage areas and added to the Great Creek watershed. This represents a 6.7% increase in the existing watershed and the peak discharge rates from the basin. Were it not for the drainage improvements provided by the Great Creek project, this additional runoff would exacerbate the existing flooding problems experienced by the East Broadway neighborhood homes.

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[12] Goodkind and O'Dea, Silver Sands State Park, Capitol Project Coordination Study, June 1952, p. 8.

[13] As a consequence of the closing of the landfill and the placement of fill for park development, Fletchers Creek will be filled and eliminated as a separate drainage.

Table 4

DEMERSAL FINFISH SPECIES

COLLECTED OFF CHARLES ISLAND

SEPTEMBER 13, 1979

Scientific Name	Common Name	* Average Number Per 15 Minute Tow
Pseudopluronectes americanus	Winter flounder	75.0
Scopthalmus aquosus	Sand Dab	3.0
Paralichtes dentatus	Fluke	1.0
Stenotomus chrysops	Porgy, Scup	78.0
Prionotus evolans	Striped Searobin	4.25
Anchoa mitchili	Bay Anchovy	8.0
Poronotus tricanthus	Butterfish	27.0
Cynoscion regalis	Weakfish	2.0
Trinectes maculatus	Hogchoker	0.25
Tautogalabrus adsperus	Cunner	0.25
Tautoga onitis	Blackfish	0.25
Syngnathus fuscus	Pipefish	0.25
Mustelis canis	Smooth Dogfish	0.25
Centropristes striatus	Black Sea Bass	0.25

* Average of 4 - 15 minute tows (from Pellegrino and Baker)

Table 5

EPIFAUNAL INVERTEBRATE

SPECIES OFF CHARLES ISLAND

SEPTEMBER 13, 1979

Scientific Name	Common Name	Average Number Per 15 Minute Tow
Ovalipes oscellatus	Lady Crab	38.0
Cragnon septemspinosa	Sand Shrimp	3.5
Homarus americanus	Lobster	2.75
Cancer irroratus	Rock Crab	2.0
Libinia emarginata	Spider Crab	5.25
Pagurus pollicaris	Hermit Crab	0.75
Pagurus longicarpus	Hermit Crab	1.5
Limulus polyphemus	Horseshoe Crab	0.5
Neopanope texana	Mudcrab	1.5
Asterias forbesii	Starfish	2.5
Busycon canaliculatum	Channel Welk	0.75
Loligo pelaei	Squid	2.5
Mytilus edulis	Blue Mussel	1.25
Astrangia danae	Northern Coral	0.75

(from Pellegrino and Baker)

The timeframe for construction of the Great Creek drainage improvements will precede the closure of the landfill or the commencement of the state park development work. Thus, the construction activities associated with the drainage improvements will have no effect on any development work in or use of the park. Following completion of the Great Creek project, a width of slightly in excess of eighteen feet of beach at the eastern edge of the state park will be permanently dedicated to use for the creek outlet and, thereby, lost to recreational use. This represents approximately 0.6% of the total beach length. Offsetting this loss will be the anticipated improvement in the quality of the marsh which will afford increased opportunities for viewing wildlife, interpretative uses and other forms of passive recreation.

PROPOSED GREAT CREEK FLOOD PROTECTION PLAN

Several different strategies were considered and evaluated for their effectiveness in alleviating the drainage and flooding problems at Great Creek. These are discussed in detail in the following section, Analysis of Alternative Flood Control Strategies. The various approaches considered included, either individually or in combination, enlarging and improving the existing Great Creek outlet structure, relocating the outlet channel at one of various locations in or adjacent to Silver Sands State Park, construction of a dike and pumphouse to protect the East Broadway neighborhood homes from elevated water levels in the marsh, diversion of portions of the upper watershed to neighboring drainage basins and nonstructural solutions such as floodproofing or acquisition.

Following the evaluation of each of these alternatives, the proposed flood protection plan as illustrated in Figure 3 was chosen. The major feature of this plan is the relocation of the outlet from the Great Creek basin to an alignment along and within the eastern boundary of Silver Sands State Park. The outlet structure will consist of a 5' X 16' concrete box culvert capable of passing a flow of 590 cubic feet per second (cfs). This may be compared to the capacity of the existing outlet which begins to produce flooding for any flow exceeding 77 cfs. Self-regulating tide gates and manually operated sluice gates will be set at the inboard end of the box culvert. The existing outlet will be closed and plugged. Each item of the plan is discussed below.

Channel Relocation

In place of the existing channel Soundward from the confluence of the East and West Branches of Great Creek, a new channel will be excavated commencing approximately 1,500 feet up the West Branch from their juncture. This channel wil be 2,340 feet long with an invert elevation of 0.0., NGVD. The first 550 foot segment will be roughly parallel to the existing West Branch channel and will have a width of 30 feet with 2:1 side slopes. At the end of this segment, the West Branch flow is picked up via a 100 foot segment of 30 foot channel thus defining the location of the new confluence of the two branches.

From this point, the channel widens out to 40 feet and proceeds generally southerly for most of this 1,790 foot segment, gradually dropping down to elevation -0.8. at the point where it intersects the tide gates and the northern end of the box culvert. This point is located approximately 160 feet north of the intersection of the Service Road and East Broadway (see figure 3).

One additional segment of new channel will be constructed to bypass the existing confluence and carry the East Branch flows toward the new outlet channel. Six hundred feet of 30 foot channel will be excavated, side slopes again being 2:1, with another 200 feet of 20 foot channel to tie in the drainageway that passes beneath and collects flows from portions of the watershed east of Surf Avenue.

The total length of channel relocated or improved will be 3,190 linear feet.

An estimated 10,000 cubic yards of material will need to be removed to construct the new channel. Borings indicate that this material will be mostly organic in nature, the remains of Phragmites and even Spartina which have accumulated in the marsh. Below this layer are sandy deposits, some of which will also be removed. This material, along with approximately 1,300 cubic yards of additional similar material excavated for the box culvert, will be disposed of in the landfill area just to the north of the service road.

Box Culvert, Timber Training Walls

Flows from the relocated Great Creek channel will leave the marsh and pass under East Broadway via a reinforced concrete box culvert. This box culvert will be 5' X 16' in cross section with an overall length of 315'. The culvert will be laid in a straight line. It will drop 0.2 feet in elevation over its length with its inlet invert set at -0.8 NGVD and its outlet end at -1.00 NGVD.

From the downstream end of the box culvert, two timber training walls will define the sides of an 18 foot wide open channel to Long Island Sound. The walls will be of timber pile and wood sheeting construction, will stand six feet tall, and will extend for 180 feet from the outlet of the box culvert.

Both the box culvert and the open channel will be entirely on State property adjacent to the property boundary. Costs for these two components are estimated (1983) at $172,800 for the box culvert including excavation, installation, backfill and road restoration and $79,500 for the timber training walls.

Control Structures

The control structures will be located in a precast concrete vault, 50'6" long by 32' wide, located at the upstream end of the box culvert. Two 4 1/2 ft. by 6 ft. tide gates and two sluice gates of the same size will be mounted in series in this vault to regulate incoming tidal flows. In addition four 2 1/2 ft. by 2 1/2 ft. flapper gates will be mounted parallel with the tide gate, one on either side of each gate, to augment discharge capacity under peak flow conditions.

The tide gates will be the primary control on tidal flows. The function of a tide gate is normally to block or limit incoming tidal flows while allowing for the normal discharges from the coastal pond, marsh or embayment to occur at low tide as soon as the head behind (inboard of) the tide gate exceeds the water level outside. Standard tide gates eliminate the tidal flushing action necessary for the maintenance of salt marsh vegetation by preventing the interchange of saltwater and freshwater during incoming tides.

For Great Creek, the tide gates being proposed for installation are non-standard in that they may be adjusted (over a four foot range) to allow for a wide range of rates of tidal inflow and exchange. This design of tide gate, known as a self-regulating tide gate, is a recent innovation. Its chief advantage over conventional gates is to allow for the maintenance of salt marsh vegetation and characteristics or, in cases where restricted circulation has previously eliminated characteristic salt marsh vegetation, to allow for its restoration. An example of an apparently successful salt marsh restoration using self-regulating gates can be seen at Pine Creek in Fairfield where they were installed three years ago. For more information on self-regulating tide gates, see Appendix A.

Although the self-regulating tide gates are very simple in design and have operated very reliably to date, they are a fairly new development. Therefore, the manually-operated rectangular sluice gates will be installed as a redundancy in the event that any problems develop with the tide gates. Each sluice gate will be 72" wide by 54" high. Under normal operating conditions, they will be set full open to allow tidal inflow to be regulated by the tide gates. If the tide gates should need maintenance or repair work, the sluice gates can then be adjusted to limit incoming flows.

The sluice gates will also yield an added benefit in channel maintenance should sediment build up in the culvert or open channel or should routine channel cleaning be desired on a regular basis. This could be accomplished by closing the sluice gates at high tide just as outflow from the marsh begins. When the tide has fallen to its low point in Long Island Sound, and therefore the available head is at its maximum, the sluice gates would be opened. The resulting surge of water released from the marsh at maximum head would flush any accumulated downstream sediment from the culvert or the open channel.

<u>Closure of Existing Outlet Channel</u>

Upon completion of this project, Great Creek will enter Long Island Sound via a new channel 1,800 feet west of the existing outlet. Consideration was given to retaining the existing outlet and allowing it to function in tandem with the proposed new outlet channel. This option was discarded for two reasons.

First, the culvert capacity of 86 cfs is small compared to the 590 cfs flows which the proposed 5' X 16' box culvert will be capable of discharging. More importantly, the considerable existing clogging and maintenance problems with this outlet will increase once the majority of the flow of Great Creek is shifted to the new outlet. The remaining minor flow would not be sufficient to keep the culvert from becoming plugged with sand and debris. In order to keep this outlet open and functional, frequent cleaning of the culvert and outlet channel would be required. The benefits to be derived do not justify this level of effort.

Therefore, the existing outlet will be abandoned and closed. To accomplish this, the final four 8' lengths of 48" pipe will be removed and a concrete plug placed in the remaining section of pipe. The beach will be backfilled to pre-project contours following the removal of these pipes. Two access chambers south of East Broadway and the box culvert inlet on the north side of East Broadway will be similarly abandoned and plugged. Closure will be accomplished using a combination of concrete and large rocks or rock fragments as filler.

The existing channel from East Broadway upstream to the confluence of the East and West Branches will either be backfilled and graded to meet surrounding contours or may be left intact as an open waterway should that be the preference of abutting landowners and also found to be compatible with the flood control plans during final design.

Project Cost

Total project cost for the proposed plan is estimated at $501,300 (August 1983)*. This may be broken down among individual project components as shown below.

Channel improvements and relocation	$104,500
Box culvert(5' x 16', 315' length), installation	172,800
Tide gates-two 72" x 54" rectangular, self-regulating gates	62,000
Sluice gates-two 72" x 54" manual gates	62,500
Training walls-timber pile and wood sheeting	79,500
Outlet closure	20,000
Total Cost	$501,300

*Prior to the release of this Environmental Impact Evaluation, a set of revised cost figures were submitted by DTC as part of the basic design package. According to this April 1984 estimate, the cost of the project is $716,995. Because these revised figures are in a different format than the 1983 cost breakdown, it was not possible to directly substitute the new figures into the text of this EIE. The updated cost estimate is, however, included in this report in Appendix E.

Advantages of Selected Flood Control Plan

The selected option is the least costly of all the plans evaluated for protecting the homes in the lower Great Creek basin from flooding damage. As can be seen in the following section of this report, Analysis of Alternative Flood Control Strategies, the chosen scheme also possesses several other advantages compared to some or all of these alternatives.

Construction will take place totally within the boundaries of State property. This will minimize the need for both construction and maintenance easements. It also avoids the taking of residential properties, a factor which boosted the cost of some of the other alternatives.

Other advantages of the selected plan, discussed in more detail later, include no constraint on the width of the discharge channel, thus allowing more efficient drainage from the marsh, and no automated components. The latter feature means lower maintenance costs since no testing, servicing or repairing of pumps or other equipment is required.

One final benefit of the chosen alternative is the avoidance of the use of diking. Several of the alternatives considered involved the construction of up to one mile of dike. By circumventing the need for such a structure, the construction and maintenance costs associated with the dike were eliminated. This non-dike alternative is also much less land consumptive and avoids the creation of an attractive nuisance.

Construction of Improvements

Construction of the drainage improvements herein described is anticipated to require six months. The preferred interval is late spring, beginning in late May or June after the heaviest rains, and extending through to autumn. Drier weather conditions will expedite the work process.

The initial phase of work will involve excavation for the new outlet channel. During this phase, the inland portions of the channel will be excavated but not connected to Long Island Sound. Ten thousand cubic yards will be removed during this work. This material will probably be disposed of within the Milford Landfill in an area immediately northwest of the intersection of the park service road and Samuel Smith Lane.

Excavation of the trench for the box culvert will be the second phase. This would commence with the removal of 3,000 cubic yards of material to form the trench for the culvert. A gravel base would be laid, graded to proper elevations and compacted to provide a base which would not be subject to settling or shifting. The culvert comes in eight foot sections which are individually lowered into place by a small crane. The sections have an interlocking lip design and a bituminous sealer is applied at the joints. Following the placement of the culvert sections, 1,700 cubic yards of backfill will be used to close the trench back to grade. The remaining 1,300 cubic yards of spoils will be landfilled with the channel spoils.

During culvert installation, East Broadway will probably be closed to traffic at the eastern boundary of the state park. Another option may be to install one half of the culvert at a time while traffic is maintained on the opposite lane of East Broadway. The practicality of this will be assessed at the time of construction. Installation of the culvert and, therefore, the closing of East Broadway would take a maximum of one week.

The vault which will house the tide gates and sluice gates will be installed at the same time as the box culvert. The same work elements are involved. The inboard end of the culvert trench will be deepened to form a pit. A gravel base is laid onto which the precast concrete vault is lowered by crane. The gates are then installed in the vault and a steel grate is placed over them and locked. The tide gates will be placed at the upstream end of the vault with the sluice gates to the Soundward end.

Construction of the training walls is an independent element which may be undertaken at any time during the construction sequence.

Closure of the existing outlet would be the final element of the project. The elements involved in this phase are contained in the previous discussion of closure. If the channel north of East Broadway toward the existing confluence is filled to grade, an estimated 1,000 cubic yards of fill would be required.

The requirement for construction easements will not be determined until final design. Additional easements, if necessary, will likely be minimal. The new outlet and relocated channel will be located totally within State property. Depending on the proximity of the culvert and open channel to the private property boundary, some minor width of construction easement may be sought to facilitate equipment operation. At the existing outlet, a 12 foot maintenance easement was previously established to allow for necessary cleaning and repair of the outlet pipe and channel. Use of this easement to remove pipe sections and fill the channel is planned. Additional easement width will be acquired if necessary.

Maintenance of the completed project will consist of servicing and adjusting the tide and sluice gates, maintenance of channel slopes, mowing grass that will be used to stabilize portions of the channel slopes, and clearing the gates, culvert and channel of any debris or sediment which may accumulate therein. It is not anticipated that any permanent maintenance easements will be needed to perform these tasks.

ANALYSIS OF ALTERNATIVE FLOOD CONTROL STRATEGIES

Before arriving at the solution described in the preceding section, numerous alternative strategies and combinations of measures were considered to alleviate flooding in the Great Creek Basin. These involved improvements to the existing outlet, upstream channel improvements, construction of a new outlet and a relocated creek channel, diversion of a portion of the surface flow entering the Great Creek Basin, floodproofing of affected homes, acquisition of affected homes and properties and the extension of the existing outlet beyond the intertidal zone. Each of these possible solutions, together with the "no action" alternative, will be discussed in this section.

Improvements to Existing Outlet

Because the present flooding problems along East Broadway and adjoining streets are caused primarily by the inadequacies of the existing outlet structure, increasing the capacity of this outlet was the first remedial step to be evaluated. This was considered both as a freestanding action and as an element in a larger project.

Enlargement of the existing outlet as a freestanding action was analyzed and found to be unable to remedy the drainage problems at Great Creek. Because of the proximity of residential structures abutting the existing outlet, channel width is limited to twelve feet unless some of these properties are acquired. This width of channel is insufficient to handle the design flows. In addition, if the opening of the channel is increased without providing some form of tidal flow control structures, the frequency and severity of tidal flooding in the basin could be increased. For these reasons, improvements to the existing outlet were dismissed as an alternative unless combined with other protective measures.

Another plan which would use the existing outlet and which was considered in greater detail contained many of the elements of the proposed project. Under this plan, the flow of Great Creek would be intercepted just west of the existing confluence of the two branches and would be conveyed to and under East Broadway by 715 feet of 4' x 12' box culvert. Approximately 850 feet of new stream channel would need to be constructed to relocate the confluence to the head of the culvert alignment. By passing through several residential properties on a direct route to the sound, the new culvert alignment avoids the circuitous route the lower creek now uses. This, however, requires the acquisition of all or portions of several properties and the removal of three structures including two homes, increasing both neighborhood impact and project cost.

Control of tidal flows in this system is accomplished via a tide gate-sluice gate arrangement similar to that contained in the proposed project. A vault structure would be built into the northern end of the box culvert to house the gates. Extending from the soundward end of the box culvert, two timber pile and wood sheet training walls would confine the outlet channel until it reaches elevation -1.00. This section of open channel measures 180 feet in length and 15 feet in width.

The estimated cost of the above system is $754,300 (1983). This plan was judged to be less desirable than the proposed plan due to the necessary property acquisitions, the estimated cost being 50% above that of the proposed action and the lack of any offsetting advantage in efficiency as compared to the proposed project.

A third scheme includes all the elements of the above, except the sluice gates, but incorporates a 5,250 foot dike around the southern and eastern perimeter of the marsh. The dike would average four feet in height with 1:4 side slopes and a ten foot top width. The dike provides an extra measure of protection in larger flooding events by containing flood waters in the marsh rather than allowing them to spread onto the lower elevations of the roads and yards at the northern ends of the affected side streets. It also requires a mechanism to drain the water which will collect on its southern side resulting from the collection of drainage in the 47 1/2 acres between East Broadway and the dike. For this purpose, a pumping station capable of handling 73 cfs is proposed just south of the dike on Blair Street.

The construction of the dike gives extra protection from inland flood flows but, as with the situation caused by runoff from the residential area collecting south of the dike, coastally produced runoff could also be impounded by the dike and prevented from draining into the marsh, producing a 'bathtub effect' on its south side. This could arise in storms, such as that of March 29, 1984, where storm-driven water from the Sound flows over East Broadway. To alleviate this problem, a drawdown facility consisting of a 12' x 4' box culvert through the dike and three 42" x 42" sluice gates is envisioned at the end of Silver Street to drain this water to the marsh.

The addition of diking adds several major costs to the project. These include (1983 estimates) $135,500 for the dike, $374,800 for the pump station and $63,500 for the drawdown facility. With these costs, the total estimate for this alternative is $1,232,100.

Although under certain conditions, the diking does provide an extra measure of protection, this alternative and another diking alternative to be considered next possess a number of undesirable features. Cost is a major drawback. Another is reliability. The pumps must be maintained, repaired and periodically tested. This involves extra labor and a consistent maintenance effort. Even then, the possibility of malfunction always exists with any mechanical device. The non-dike alternatives rely exclusively on gravity, a much more dependable power source. The dike alternative just described again requires the acquisition and demolition of three structures. For reasons of cost effectiveness, reliability, ease of maintenance and acquisition requirements, the diking alternative was deemed less practical than the selected option.

Drainage Improvements Using Westerly Outlet With Diking

A fourth strategy which was evaluated in some detail consists of a combination of the proposed project and the diking alternative just described. The channel relocation, box culvert, tide and sluice gates and timber-lined open outlet channel would be exactly as proposed in the project description section. In addition to these improvements, the same 5,250 foot dike and the pump station and drawdown facility just described would function as outlined for the existing outlet option. Because relocating the marsh outlet to the park's eastern boundary (as proposed) is less expensive than retrofitting the existing outlet, the westerly outlet dike alternative is also less expensive than the first diking proposal. Those cost savings for the western outlet, either with or without the dike, arise due to a shorter length of box culvert (310 feet vs. 715 feet) necessary to the west and the avoidance of property acquisition costs since the westerly alignment is totally within state-owned land. Outletting Great Creek at the westerly location in combination with the dike, pumphouse and drawdown facility is estimated (1983) at $979,100.

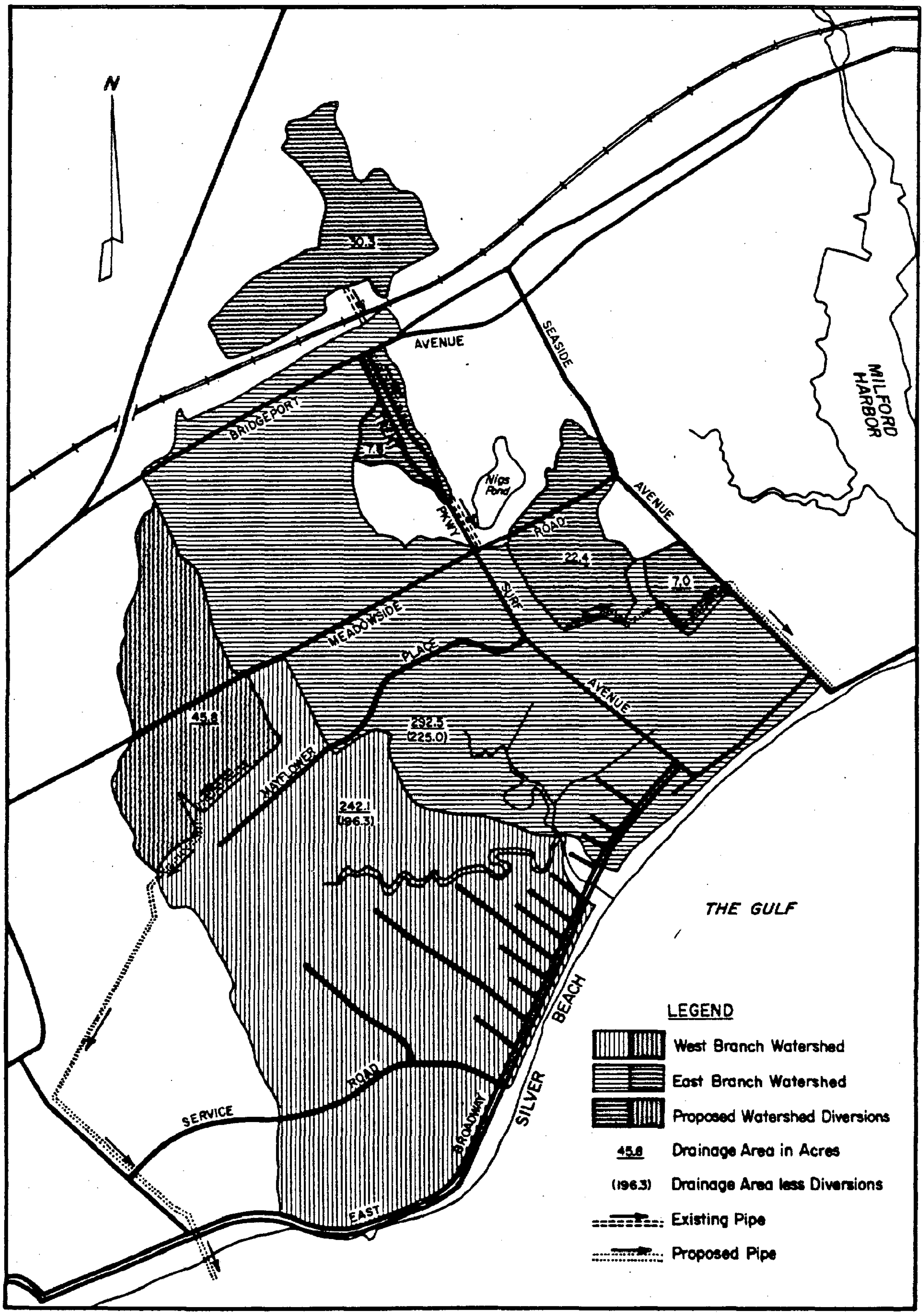
Diversion

Diversion of flow from some portions of the Great Creek basin to neighboring watersheds was analyzed in some detail to see whether the flows could be reduced sufficiently to allow cuts in the scale and cost of the Great Creek drainage improvements. Five sub-basins, shown in Figure 6, were identified from which such diversions could be accomplished. One sub-basin of 45.8 acres was delineated in the northern portion of the West Branch basin. Flow from this area could be intercepted at Pilgrim Lane and Carlson Drive and conveyed via 1,410 feet of 42" and 48" RCP to the landfill drainage system, from which it would ultimately be emptied into the Nettletown Avenue Creek. Under design storm conditions, 95 cfs could be diverted from Great Creek via this connection.

Four areas totalling 67.5 acres were judged feasible for diversion from the East Branch watershed. Flow from these areas would be directed eastward and drain into Milford Harbor.

DIVERSIONS FROM GREAT CREEK WATERSHED

FIGURE 6



The raw acreage removed from each watershed as well as the percentage of the watershed area, the percentage reduction of design flow and the cost of the proposed diversions are shown below.

Flow Diversions from Great Creek Basin

	Acres Removed	% of Watershed Area Reduction	% of Flow Reduction	Cost
West Branch	45.8	19	22	$100,000
East Branch	67.5	23	20	350,000
Total Watershed	113.3	21	19	450,000

Note that the aggregate percentage flow reduction is less than that for either branch individually because of the 36 minute gap in times of concentration between the two sub-basins. While the peak flows for each branch are reduced by 20-22%, these reduced peak flows do not coincide timewise. Therefore, the combined peak flow reduction is less than the reductions achieved in the individual basins.

Despite the apparent significance of a near 20% reduction of total peak discharge, the effect on flooding levels experienced in the basin is minimal. A 20% reduction in the 100 year peak flow of 590 cfs yields 472 cfs, precisely the discharge associated with the 25 year storm. Flood stages associated with the 25 year storm are 4.85 feet to 5.35 feet versus a tidal head of 3.5 feet or 4.2 feet respectively. For the 100 year event, the flood stage is 5.14 feet against mean high tide (3.5 feet) or 5.60 feet against mean spring high tide (4.2 feet). Thus, the reductions in flood stage experienced in the basin are .25 to .3 feet or 3-4 inches. As a freestanding solution, the $450,000 cost of the diversions can not be justified against these reductions. When considered as a component of the proposed plan, a much greater level of protection which includes the increment achievable via diversion can be realized for the estimated project cost of $501,300. The diversions, therefore, are not seen as the most cost effective available solution either as a freestanding project or in combination with the proposed plan.

Floodproofing

Floodproofing dwellings involves employing various practices to prevent the entry of waters into the structure. The most common measures are sealing openings such as basement windows and doors, earthen berming around the structures to seal out standing water, or jacking the structures up above the flood elevation.

For the homes of the Great Creek neighborhood, berming is not practical due to the extreme density and small lot size of the dwellings. Given the number of affected structures, jacking would be cost prohibitive. Sealing of basement and/or lower floor openings such as doors, windows and hatchways was considered as a possible alternative and reviewed as to cost.

As shown in Table 1, 127 homes are within the five foot contour elevation. Another 41 homes lie partially within this boundary for a total of 168 homes completely or partially built on ground below elevation 5.0 feet. This elevation was selected as the cutoff point for installing floodproofing measures.

Neither an actual count of the number of lower level building openings nor an inventory of the number of affected structures with partial basements was made. Floodproofing costs are based on an average of six openings per house at a sealing cost of $300 per opening and a contingency, overhead and profit allowance of 30%. This produces a cost figure of $2,500 per house or $420,000 for the 168 lowermost dwellings.

The cost of the floodproofing option is not unreasonable when considered as a solution to the conditions experienced at Great Creek. This alternative is at a competitive disadvantage, however, when evaluated against the proposed plan in three regards. First, floodproofing yields protection only to the homes actually treated while the drainage improvements provide relief for all homes in the basin. Secondly, while the drainage improvements will remedy inundation of homes, yards and streets, floodproofing protects only the former. Emergency access to homes on flooded roads as well as the level of general inconvenience for homeowners is not improved by floodproofing. Lastly, floodproofing has a greater impact on the use and enjoyment of the dwellings, both during and after construction. No alteration of the homes is involved with the proposed plan. For these reasons, the proposed plan is seen to offer superior protection compared to floodproofing these homes.

Acquisition of Affected Properties

The purchase of some of the more frequently flooded homes would eliminate the most severe impacts of the drainage problems at Great Creek. Properties acquired could be incorporated into the State holdings at Silver Sands State Park. Residents who are relocated would receive a very high degree of flooding protection unless, of course, they were to relocate into another floodprone area. Those residents who remain, presumably those less affected by flooding, would have to continue to deal with the level of inconvenience experienced in the past unless additional measures such as floodproofing remaining homes were added to the project.

Acquisition as a solution would avoid construction in the wetlands as well as construction impacts on the beach and at the East Broadway crossing. However, the beneficial impacts associated with marsh restoration would also be foregone because tidal flushing would not be improved. Although the construction impacts associated with the proposed project would not occur, the neighborhood would experience other construction impacts in connection with the demolition of the acquired structures.

Cost factors render the acquisition alternative infeasible. Acquisition of even 100 homes would cost several million dollars. In addition to buying the properties, demolition of the structures and perhaps relocation services for residents would represent other costs. It is likely that not all the homeowners involved would be willing sellers, so that additional legal expenses could also be involved. This alternative is not considered a viable option as a flood control plan.

Culvert Extension

A previous effort to find a solution to the flooding problems at Great Creek was made in 1974 when C.E. Maguire, Inc. was commissioned to do a drainage study. Their study resulted in a recommendation to make several modifications to the existing outlet in order to increase its hydraulic efficiency and to reduce maintenance problems.

The major feature of the C.E. Maguire plan was a 600 foot extension of the outlet pipe into Long Island Sound. The extension would use 48" corrugated metal pipe encased in riprap armor. The outlet end of the pipe would be elevated 1 foot 6 inches off the Sound bottom to prevent sediment infiltration or blockage. To increase hydraulic efficiency, the existing tide gate, which has deteriorated to a non-functional condition, would be removed and a smoother transition would be constructed between the box culvert and the pipe to reduce friction losses. Control of incoming tidal flows would be provided by the high friction losses at the rough lip of the metal pipe which would restrict average tidal inflow to 1,300,000 cubic feet. No additional control mechanism would be provided. The estimated cost of this construction was $125,000 (1974).

The C.E. Maguire recommendations were not implemented because of several concerns and unanswered questions in connection with this plan. Among these were concerns that the impervious armor around the pipe would disrupt littoral transport and could alter surrounding private beaches. The pipe extension was thought to be a potential hazard to boaters because it would be partially submerged at high tide. Cleaning of such a long section of pipe if it did become clogged, potential safety hazards to swimmers, and the lack of tidal flooding protection for Great Creek if inflows were greater than anticipated were other questions which led to the DTC study to find a new solution.

No Action Alternative

One final course of action would be to allow the existing conditions at Great Creek to continue. This "no action" alternative would avoid all construction impacts. In addition, it offers the lowest capital cost, saving $501,300 compared to the recommended plan.

There are, however, other real costs connected to this option. They occur in the forms of continued social disruption caused by future flooding and of foregone benefits which would have arisen from an improvement of the existing conditions. The foregone benefits include not only protection from flooding but increased property values once this flood threat is reduced and the likely property improvements that homeowners would make in the safer environment. The savings as Town forces are relieved from the task of the periodic cleaning of the existing outlet would also be forfeited. Also, as increased tidal flushing restores the marsh to a healthy saltmarsh system, the Phragmites related fire hazards would be reduced, aesthetics improved and mosquito breeding curtailed. These benefits would also be lost.

Further, non-implementation of the Great Creek drainage improvements would presumably not prevent the closure of the Milford landfill or the development of Silver Sands State Park from proceeding. Each of these actions will operate to increase the severity of localized flooding if no compensating improvements are made. The landfill closure will add 34 acres of watershed and runoff to Great Creek while the park development plans call for a new east-west service road along the northern perimeter of the marsh. The service road will consume some of the runoff storage volume currently available in the marsh as well as creating additional impervious surface replacing existing natural ground. In light of these upcoming developments, the "no action" alternative actually represents a deterioration from the present conditions rather than a continuation at current flooding levels.

PROJECT IMPACTS

As is the case with all construction activity, this project will result in temporary impacts during construction operations and permanent impacts associated with the structures erected. The short-term impacts, largely adverse, and measures employed to mitigate them are discussed below followed by a description of long-term impacts, largely beneficial.

Construction Impacts

The principal short-term impact, based upon potential effect on the natural environment, is increased erosion and sedimentation resulting from disturbing soils to create the new channel for the relocated Great Creek. Impacts will be felt within the Great Creek marsh and adjacent nearshore areas of Long Island Sound.

Because of the potential adverse impact to nearby shellfish resources (concentration areas shown in Figure 5), the sedimentation resulting from the construction of the new outlet is considered the most important impact to control. In order to minimize sedimentation from this source, all excavation work inland of the proposed culvert will be completed and the sediments allowed to more or less stabilize before the channel across the beach is begun. It is not feasible to attempt to further contain the materials disturbed during the construction of the relocated creek channel.

Upon the connection of the new channel to the Sound, a short term pulse loading of disturbed sediments and organic debris will be flushed from the marsh as the reintroduced tidal exchange suspends some of the material disturbed by construction. The organic component of this cleansing will be quickly degraded, while the mineral fraction will settle out in The Gulf. The latter is not of sufficient volume to cause the burial of resident shellfish. In any event, the DEP imposed prohibition on construction and dredging during the shellfish spawning season from June 1 to September 30 will be observed for the protection of oysters and other resident shellfish species. Final connection of the new channel will be consummated after this date.

Sedimentation from the channel work across the open beach area will be minimal given the small affected area and the coarse-grained material found there. Also, the marsh, in performing its natural function as a sediment sink, will trap sediments transported into it by the incoming tidal flows.

Although a major emphasis of this project is the restoration and upgrading of the Great Creek wetlands, it must be recognized that certain negative wetland impacts must necessarily be incurred in accomplishing this goal. Some wetland area will be incorporated into the new channel. In the short term, additional areas will be impacted during construction as temporary access roads are created using fill, beams, or corduroy mats for support of construction equipment. Any such materials will be removed upon the completion of the work. These temporary impacts will be offset by a substantial permanent upgrading of the marsh system.

Storage of equipment or the stockpiling of construction materials will not be allowed within wetland areas. All exposed non-wetland areas will be seeded and vegetated to foster rapid stabilization. Disturbed wetland areas will be allowed to naturally revegetate so as to induce the introduction of more favorable salt marsh vegetation. Progress will be monitored, so if exposed areas present a problem, some corrective action can be taken. Additional control measures deemed necessary by regulatory agencies can be incorporated during the permitting process by the Army Corps of Engineers or the DEP Water Resources Unit.

Impacts to air quality will result from the burning of fuels by construction equipment and the potential of releasing airborne particulates through construction activity. Gasoline powered engines emit carbon monoxide and hydrocarbons as their principal pollutants, while diesel engines emit more nitrogen oxides and particulates. The scale and duration of equipment use will not result in a significant elevation above background levels for such pollutants in the highly urbanized corridor stretching from New York to New Haven.

Many construction projects have a high potential to increase local levels of particulates through the entrainment of fugitive dust in the air column by the action of wind currents across disturbed areas. For this project, the preponderance of disturbed land will be wetland soils of the marsh with little resultant potential to generate fugitive dust. When appropriate in drier areas, as in the crossing of East Broadway for example, or during trucking of excavated material, necessary control measures will be employed by the contractor to minimize fugitive dust problems. These include application of dust control agents such as calcium chloride to disturbed areas and tarpaulin covering of loaded truck beds.

Other construction impacts, namely the disruption of East Broadway traffic, increased noise levels and the general disturbance to the residential neighborhood, will temporarily affect only those people who will also receive the greatest benefit from the project, the residents of the Silver Beach area. The construction period is expected to last six months. The following measures will be employed to minimize these impacts.

During installation of the box culvert under East Broadway, two-way traffic will be obstructed. However, one travel lane for alternating use by traffic in either direction will be kept open, if at all possible, so as to maintain the utility of this roadway. If, during final design, it is determined that installation techniques require total closure of the road, traffic disruption will last about one week.

Typical levels of noise generated by various kinds of construction equipment are graphically displayed in Figure 7. The greatest noise levels will result from impact equipment, such as pile drivers used during erection of the training walls and jack hammers used during construction under East Broadway. Residents at the western end of East Broadway will be most affected by these activities.

Construction noise is specifically exempted by regulations promulgated by the Department of Environmental Protection to control noise (Section 22a-69-1.8(g) Regulations of Connecticut State Agencies). In order to mitigate potential impacts, construction activity will be limited to daytime hours. Also, the contractor will be allowed to use only properly muffled internal combustion engines.

Although virtually all of the construction activity is on State property, the accustomed day-to-day neighborhood atmosphere will be temporarily disrupted. Construction vehicles will traverse local roads and be operated immediately adjacent to private property in many areas. Any operation of construction equipment on private property will require a construction easement. The maintenance easement along the existing route of Great Creek south of East Broadway will be used during plugging of the old culvert. Additional easements may be needed to fill the old channel north of East Broadway and where the rerouted channel is closest to private property.

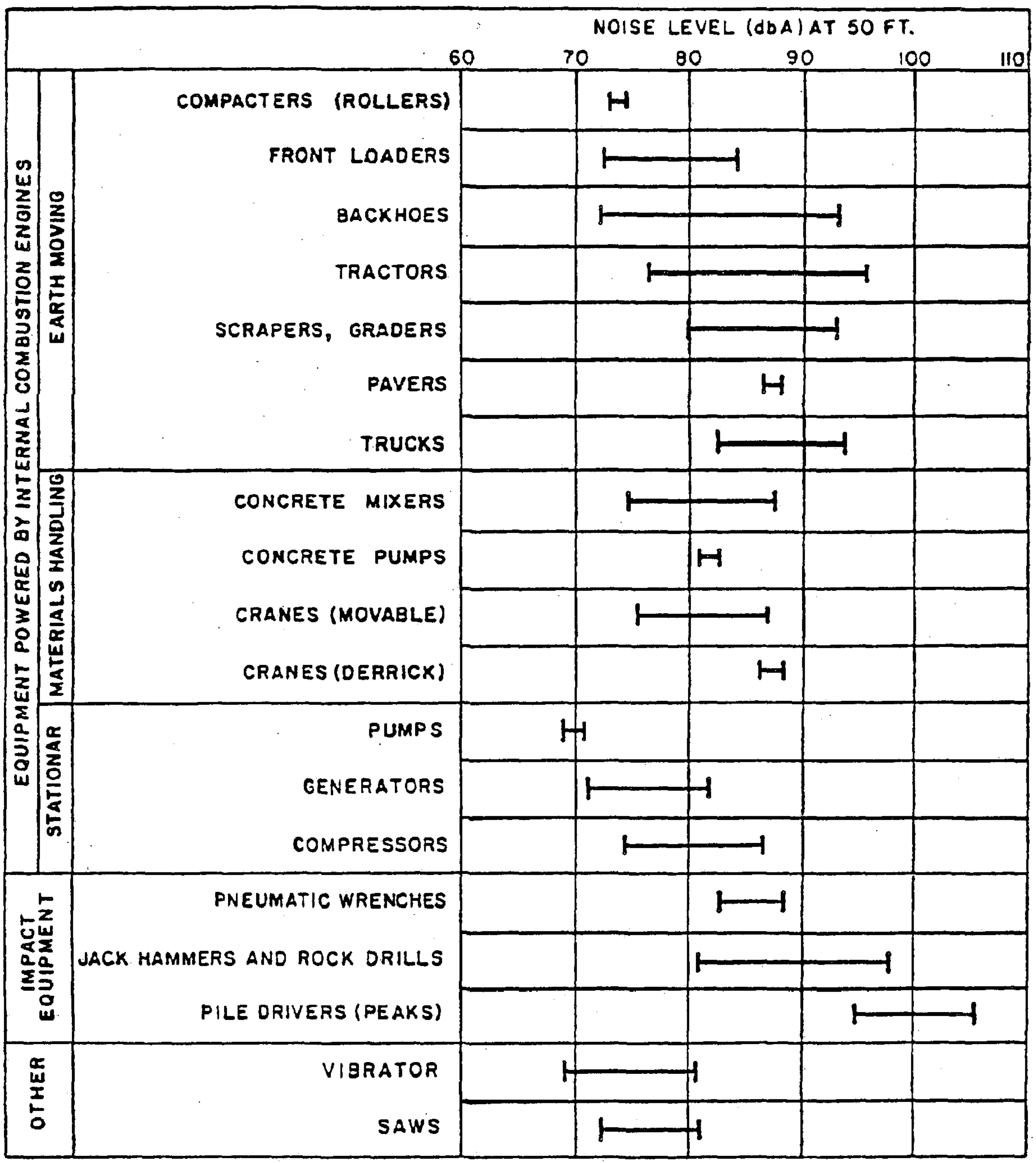
Construction will not impact any rare or endangered species of flora or fauna. The Natural Diversity Data Base maintained by the DEP Natural Resources Center lists only one species in the general area of the project: historic records of a rare grass. Beach Needlegrass (<u>Aristida tuberculosa</u>) had been known to exist along sandy beaches in the area, but has not been observed recently. The two small segments of beach to be disturbed by construction activity are presently heavily trafficked and are not inhabited by this species.

This document will be reviewed by the Connecticut Historical Commission to assess any potential impact to archaeological or historical resources. The recommendations of the State Historic Preservation Officer (e.g. conducting an archaeological survey) will be implemented as the project proceeds.

Because the relocated channel is confined to the border area of the state park, the project will not adversely impact future plans to develop an intensive saltwater swimming facility. In fact, as it is sized to accept runoff from portions of the park, it is a prerequisite to future development. Excavation for the channel will not disturb any areas previously used for landfill.

CONSTRUCTION EQUIPMENT NOISE RANGES

FIGURE 7



Note: Based on Limited Available Samples.

Disposal Impacts

Because the amount of excavation greatly exceeds the amount of filling in this project, it is anticipated that approximately 11,000 cubic yards of excess material will remain and require disposal. This material can be characterized as being saturated sandy soils with a high proportion of organic content, much of it decomposing.

A preliminary disposal site has been identified and is depicted in Figure 8. This area, northwest of the intersection of the Service Road and Samuel Smith Lane is totally within the state park and has been previously filled during landfill operations. It is identified in the 1978 Landfill Closing Plan by Fuss and O'Neill as being underlain by burned dump residue. Preliminary plans for the development of the state park have included this section as an area of minimal development as it is slated for overflow parking and passive recreation.

Being previously disturbed, this area supports vegetation typical of such sites including Phragmites, staghorn sumac, grey birch and bayberry. The area outlined in Figure 8 is over 40,000 square yards (or approximately nine acres) so that, if uniformly spread, the disposed material would be less than one foot in depth. Final grades will slope toward both roads and should be within the final grades recommended for development of the park.

Long-Term Impacts

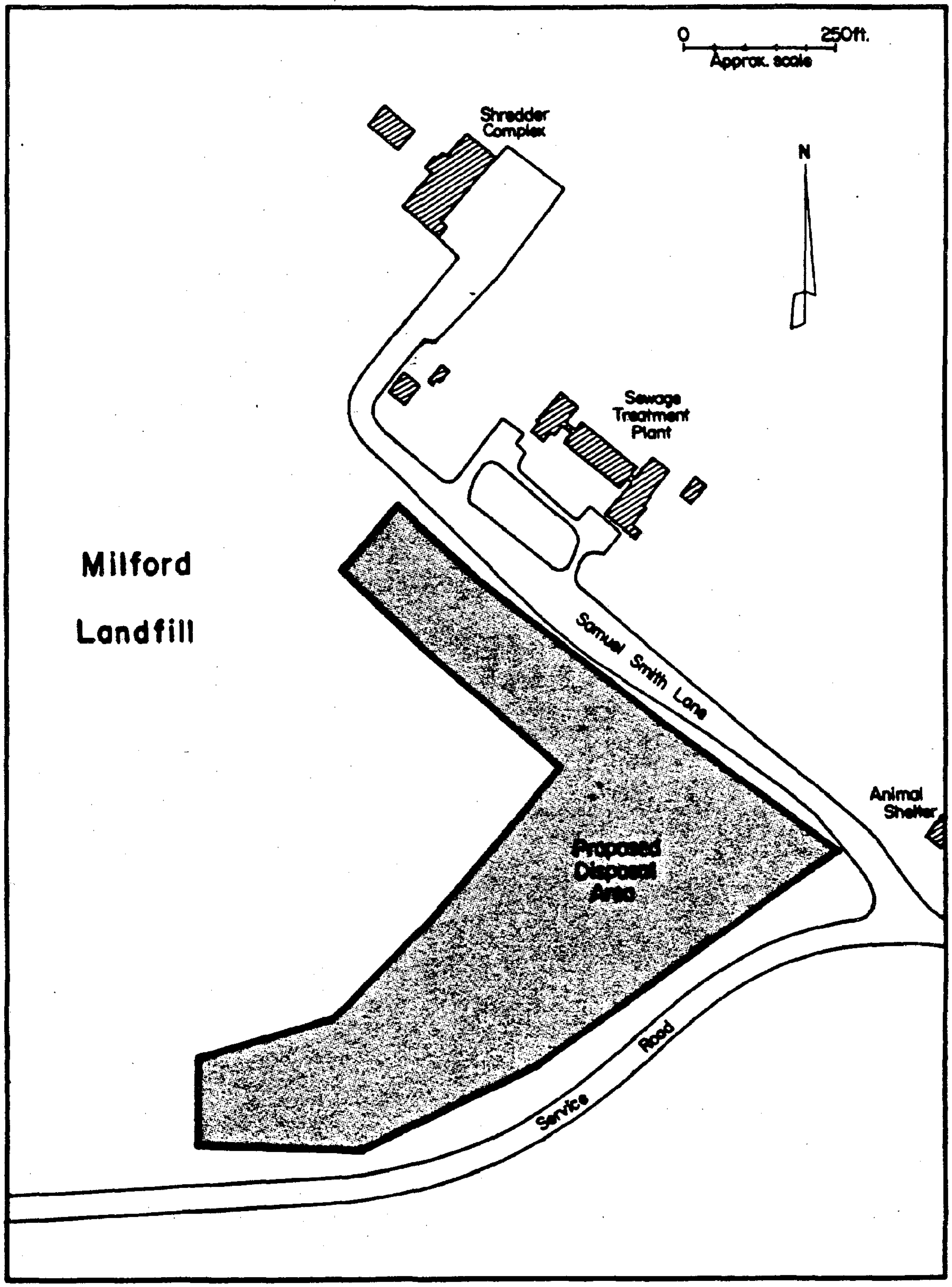
The most important long-term impact, the purpose of the project, will be to provide an increased measure of flood protection to the existing residences. The project will result in increased drainage of the Great Creek system and thus some relief from flooding caused by precipitation. The tide gates will provide protection against coastal flooding during smaller storms but cannot prevent storm tides from overtopping East Broadway during major storm events. In all cases, the duration of flooding will be reduced to the length of one tidal cycle, whereas it now can last up to five days. Quantification of the degree of protection afforded by the project can be found in the discussion of Costs and Benefits.

An extremely important side effect of the proposed drainage improvements will be the benefits to the environment that result as the increased tidal flushing promotes restoration of the Great Creek marsh. The following description of a characteristic salt marsh is taken from the Pre-Design Report by Diversified Technologies Corporation.

> Restoration would be expected to produce a characteristic estuarine community. Elevation is a good predictor of the specific organisms expected to be present.

LOCATION OF PROPOSED DISPOSAL AREA

FIGURE 8



Below 0.0 feet MSL the environment would consist of either mudflats or tidal streams. The dominant plants would be various species of algae (seaweeds). Major benthic organisms would include oysters, several species of clams and mussels, crabs, and polychaete worms. A variety of fish, shrimp, and blue crabs would swim in the tidal waters. Ducks, geese, gulls, terns, sandpipers and other aquatic habitat birds would utilize both open water and mudflat areas.

From 0.0 feet up to about mean high tide (ca. 3 1/2 feet) would occur an intertidal marsh dominated by *Spartina alterniflora*. Ribbed mussels, crabs, barnacles and other invertebrates would live among the roots and stems. Birds such as the Clapper Rail use the intertidal marsh.

From mean high tide to mean spring high water would occur a high marsh community with a variety of species of plants, commonly including *Spartina patens* and *Distichlis spicata*. Birds and other animals are similarly diverse.

Above mean spring water occurs a transition to freshwater communities, which may contain *Phragmites*, or to upland communities. The high marsh is flooded only a few times each month by sea water, whereas the intertidal marsh is covered and uncovered twice each tidal day. The entire complex has high biological productivity, supports a diverse community and produces several species of potential economic or recreational value to man.[14]

The benefits of combining salt marsh restoration and flood control are many. The successful restoration of the salt marsh, which will require several years to a decade, will re-establish a biologically productive marsh, restore the wildlife value of the area and provide for recreational opportunities such as fishing, crabbing, bird watching and nature study. The diversity of wildlife found in a healthy *Spartina* dominated marsh is not found in the existing *Phragmites* marsh.

Marsh fires, started accidentally or deliberately, burn vigorously in dried *Phragmites*, presenting a significant hazard to adjacent property owners and users of the area. Healthy salt marsh vegetation dominated by *Spartina* does not present such a hazard.

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[14] Diversified Technologies Corp., *Pre-Design Report, Flood Control-Great Creek, Silver Sands State Park, Milford, CT*, 1983, p. 28.

A well managed salt marsh would have a significantly lower potential for promoting the breeding of mosquitoes as stagnation is eliminated. Similarly, odor problems would be reduced.

Restoration of a natural marsh will also provide pleasing new vistas to visitors at the state park and to local residents. One indirect effect of improving the marsh area will be a rise in property values in surrounding neighborhoods (in addition to that resulting from flood relief). An historic perspective on the degradation of the Great Creek marsh is presented in Appendix B.

There will be permanent impacts to the existing sandy beach as a result of construction of timber training walls to contain the open channel. The 180' long, 18' wide walled channel will occupy 360 square yards of sandy beach at the eastern border of Silver Sands State Park. Although the relative scarcity of publicly-owned sandy beach in Connecticut makes this a valuable recreational resource, this loss is considered negligible. Only 18 of 3,000 linear feet, or 0.6%, of the state-owned shorefront will be forfeited. Moreover, the entire 4.5 mile stretch from Milford Harbor to Milford Point is predominantly sandy. Also, the drainage improvement project is a prerequisite for eventual development of Silver Sands as an intensive saltwater swimming facility.

The training walls will also impact littoral transport phenomena which redistribute sand along this stretch of coast. In general, sand transport in this area tends to result in net east-to-west movement. The training walls will obstruct this flow, resulting in a build-up of sand on their east side and a reduction of beach nourishment for areas immediately to the west. Because the tombolo connected to Charles Island, approximately 800 feet to the west, acts very effectively in a similar manner, only the intervening stretch of beach will be affected. This area is presently the widest, most sandy section of beach in the area and, with the tombolo and training walls acting as terminal groins at either end, should remain stable. Any additional artificial sand nourishment which may be needed to develop the state park for swimming will receive an added measure of protection due to the presence of the walls.

Littoral sand transport is not expected to block the channel entrance since the structure will extend seaward to -1.0' NGVD to attenuate potential impacts. The channel is also sized so that velocities for normal incoming tides will not be sufficient to carry sand up the channel (mean spring high tide velocity = 3.55 feet/second).

Erecting this structure across open beach will have attendant aesthetic effects. The wall will rise 6 feet above the existing grade as a maximum at its seaward end tapering to one foot at its landward end as the beach slopes up along its length. It will be very similar in appearance to the training walls which protect the outlet at the end of Nettleton Avenue at the opposite end of the state park. Although there will be some visual impact, it will be but one of several structures perpendicular to the shore in the area and will serve as a visual partition between the private residences and beach to the east and the public beach to the west. However, the right to public access below mean high water will not be unreasonably impaired since the structure will extend only to elevation -1.0' while low tide elevation is at elevation -3.5' thus permitting passage around the seaward end.

PUBLIC PARTICIPATION

The public has been involved in the development and selection of the proposed flood protection project. Both municipal officials and local residents have been consulted during the planning stages. Additional input will be obtained through review of this document and during the permitting process.

The major forum for public participation was an informational meeting held on September 21, 1983 in Milford. (See Appendix F) Various alternate plans, as detailed in the section Analysis of Alternative Flood Control Strategies, were explained to local citizens. The general consensus of the meeting was to proceed with the proposed plan of the relocated channel. Slight revisions to the plan suggested at this session were considered during subsequent design. Previously, town officials from the Engineering Department and the Flood and Erosion Control Board had reviewed preliminary designs.

All comments received during review of this document, which will be distributed to municipal officials, the Silver Sands Association and any person requesting it, will be considered before project implementation. Another opportunity for comment will be during any public hearings and public notice periods required for the various permits.

PERMITS AND APPROVALS

This project will require a number of permits from Federal and State regulatory agencies. The applicant in each case will be the Department of Environmental Protection, Water Resources Unit, Flood Management Section. Required permits are:

- Inland Wetlands Permit (pursuant to section 22a-42 Connecticut General Statutes) from DEP, Water Resources Unit, Wetlands Management Section.

- Structures Permit (pursuant to section 22a-361 Connecticut General Statutes) from DEP, Water Resources Unit, Wetlands Management Section.

- Diversion Permit (pursuant to section 22a-368 Connecticut General Statutes) from DEP, Water Resources Unit, Wetlands Management Section.

- Permit for Discharge of Fill Material into U.S. Waters (pursuant to section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act) from the U.S. Army Corps of Engineers.

- Water Quality Certification (pursuant to section 401 of the Clean Water Act) from the DEP, Water Resources Unit, Wetlands Management Section.

In addition, because the project is within the 100-year flood zone on the community's Flood Insurance Rate Map and involves State funding, it must comply with Executive Order 18 on floodplain management which is administered by the DEP Water Resources Unit.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS

As is the case with any construction project, the materials utilized and the energy and capital expended to complete the project must be viewed as irreversible and irretrievable commitments of resources. Neither the nature nor quantity of these expenditures are considered to be sufficiently significant, when compared to benefits of the project, to warrant any reappraisal of the proposal.

The principal construction materials are the concrete, timber and hardware for the culvert and vault, training walls and tide and sluice gates. The energy consumed will be the gasoline and diesel fuel powering the construction equipment. (A more energy intensive alternative involving pumping stations was rejected.) State capital for the project has already been allocated by the General Assembly through Special Act 83-17, Section 2(e)9.

The land which the proposed diversion traverses will be committed to this flood control use for the foreseeable future and can also be considered to be an irreversible commitment. The inland areas of open channel will have the natural character of a tidal creek. The open channel crossing the sandy beach will result in the loss of 300 square yards of this recreational resource.

RELATIONSHIP TO LAND USE PLANS AND POLICIES

The proposed drainage improvement project is consistent with all applicable land use plans for the area, most notably the State of Connecticut Conservation and Development Policies Plan 1982-1985 and the policies of the Connecticut Coastal Management Act.

The Conservation and Development Policies Plan classifies a portion of the project area as existing preserved open space (Silver Sands State Park) with the remainder being conservation area on the basis of its being within the 100 year coastal flood hazard area as determined by the Federal Emergency Management Agency. Virtually all of the proposed diverted routing of Great Creek will be within the limits of the State Park. Locating an open channel in this area will retain its character as open space. Restoration of the marsh will enhance its aesthetic, wildlife habitat and passive recreational values. The project will protect existing residential use of a conservation area, yet will not promote future additional development, e.g. through the creation of buildable land.

The Coastal Management Consistency Review Worksheet for this project may be found in Appendix D. The project is consistent with all applicable coastal land and water resource, coastal use and government process policies identified in the Coastal Management Act (Section 22a-90 through 22a-112 Conn. General Statutes). The project will involve the creation of an open channel with timber training walls crossing an existing sandy beach. As noted in the Project Impacts section, this arrangement will modify only 300 square yards of existing sandy beach and will not unreasonably impair public access below mean high water. The visual impact of the open channel with timber walls could be considered to be fairly significant, but this method of channel confinement is less expensive than alternate,lower profile options such as stone groins and is not dissimilar to other coastal structures in the area (e.g. the Nettleton Ave. outlet).

Because virtually all construction activity will be within the boundaries of the state park and neighboring land uses will not be affected, except for the reduced flooding potential, the proposed drainage improvement project would not be inconsistent with any local or regional land use plans. The Town's Municipal Coastal Program includes a recommendation to preserve existing wetlands.

COSTS AND BENEFITS

Implementation of the drainage improvements outlined in this report will achieve a number of beneficial ends. On the other hand, various costs, commitments and impacts must be borne to reach these goals. The following evaluation is a summary and comparison of the costs and benefits arising from the proposed action. Due to the paucity of any firm damage figures or actual records from past flooding events, this benefit : cost comparison must be described in narrative fashion rather than attempting to define a mathematical ratio to justify the project. Where available, estimates from the Diversified Technologies pre-design report are included.

Costs attached to this project fall into four categories. These are the monetary expenditure for the project, the land committed to flood control use, resources consumed either during construction or permanently committed, and the construction impacts experienced locally by both the human and biotic environments.

The monetary cost of the project is estimated at $501,300 as of 1983. The breakdown of this total among project components is shown on page 30. All funding for this work will be provided by the State of Connecticut from bonding authorized by Special Act 83-17, Section 2(e)9. A total of $6,500,000 has been allocated for the Silver Sands State Park landfill closure and the Great Creek drainage improvements. Upon the authorization of the State Bond Commission, funds can be drawn from this allocation through the issuance of state general obligation bonds.

The land commitment to this project consists of a narrow strip of property generally paralleling the southern edge of the Great Creek marsh and then crossing under East Broadway and across Silver Beach to The Gulf. The channel works in the marsh will extend in three segments for a length of 3,190 linear feet varying in width from 20 to 40 feet. The box culvert conveying the flow from the end of the relocated channel under East Broadway and opening onto the beach will extend 315 feet with a 16 foot width. It will flare out to a width of 32 feet at the gate vault. The third segment of the outlet works, the open channel across Silver Beach, will occupy 360 square yards of beach at the eastern end of Silver Sands State Park.

The loss of the beach property is the only one of these three commitments of land with any significant impact. The box culvert will occupy non-marsh, non-beach property and will be buried resulting in no loss of actual land surface. As for the new channel through the marsh, much of it either uses existing creek bed or closely follows sections of existing bed which will be abandoned. The loss of any marsh acreage is also compensated for by the anticipated improvement in marsh quality as a result of improved tidal flushing.

In contrast, the beach property consumed represents 360 square yards of high recreational potential for which this project offers no compensation. Using the current standard of 75 square feet per beach user, the outlet channel would usurp the opportunity of 43 people to enjoy the beach under a peak demand situation. At the present, this is not an actual loss because of the level of use and adjacent available beach. However, if the state park is developed, it can be expected to operate at capacity on several occasions during the year. Under these circumstances, the loss of this land would have a small but direct impact. It should be pointed out here that the 18 foot width of beach used by the channel is 0.6% of the total 3,000 foot length of the Silver Sands State Park beach.

The resources used in this project include various construction materials, chiefly concrete, steel and timber, and the energy used to operate the machinery employed during construction. Crushed stone will also be used in setting a base for the box culvert and gate vault. The energy use will be a short-term one, ceasing upon completion of the project. The construction materials used are not of a scarce or strategic nature. Due to the small quantities of both materials and energy used, their use at this site will not strain local supplies nor cause price aberrations.

Construction impacts connected with this project will consist of the noise generated by the use of construction equipment, truck traffic as excavated material is removed from the site, the disruption of normal traffic flow on East Broadway as the box culvert channel is excavated and the culvert set in place, and a disturbance to the marsh habitat as the new channel is created and the previous one filled. Each of these impacts is of short duration, lasting through all or a portion of the six month construction period. For instance, the disruption to traffic as East Broadway is blocked or reduced to one lane will last only during the time the culvert is placed. The truck traffic will occur only during the channel excavation. Therefore, not all these impacts will last the full six months.

These construction impacts are considered to be acceptable because the impacted parties are also the ones receiving the greatest benefit from this work. Most of the neighborhood disruption will be experienced by the residents of the lower Great Creek basin who are the beneficiaries of the drainage improvements. Impacts to the marsh system are short-term while the reintroduction of adequate tidal flushing will yield long-term gains in marsh productivity, diversity and quality.

Two final items should be entered on the cost side of the ledger. While the projected useful life of the drainage works is 100 years, the tide and sluice gates have an anticipated life of 25 years. Therefore, these items, which together have a cost of $124,500 in 1983 dollars, may require replacement three times within the lifespan of the culvert.

The final item concerns the gradual conversion of the marsh from Phragmites to salt marsh vegetation. As a result of greater tidal flushing and a more saline environment in the marsh, the Phragmites should experience a gradual die-off. Some of this may rot in place but most will be floated out of the marsh. This will produce unsightly concentrations of floating canes at the culvert entrance and also into The Gulf. During the height of the conversion, the Phragmites canes will probably necessitate extra maintenance to prevent or remove blockages and clogging at the tide and sluice gates. It is impossible to predict how long this conversion will take or what the magnitude of the aforementioned conditions will be during the process. These impacts will occur during an intermediate term timeframe commencing from the completion of construction.

Like the costs involved, the benefits to be realized through this project also fall into several categories. Loosely, these can be grouped into flood control, marsh restoration and public works maintenance. Since flood control is the primary purpose of this project, let us consider that first.

There are 260 occupied homes in the project area. These are subjected to varying degrees of flooding depending on their location and elevation. For the more significant storms, yard and road flooding may persist for as long as five days. On a shorter term, flooding of the actual living space of some of the lower homes occurs during major storms. It is in the rectification of these conditions that the primary benefit of this project will be realized.

There are 168 homes in the project area which lie in whole or in part within the 5.0 foot contour line. The yards of most of these reach to lower elevations. Virtually all of the side streets off East Broadway are below elevation 4.5 at some point, most are below elevation 4.0 for some portion of their length and several drop down to elevations of 3.4 to 3.6. Therefore, road flooding is also a serious problem in this neighborhood. Despite the DTC analysis showing a stillwater flooding elevation* in the basin of 5.0 feet for the 5 year event, based on input from local sources, it appears that such conditions are experienced at a much greater frequency than this.

If this project is successful in achieving its intended goals, the problems experienced by local residents as described above will be alleviated to a considerable degree but not totally eliminated. This point must be understood. Given the very low elevations of the project area, complete protection under all

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*Stillwater flood routing assumes no outflow from the basin during the duration of the storm event. Due to the constricted nature of the existing outlet, stillwater calculations should produce results which are only slightly conservative.

circumstances is not possible. The local residents and city officials understand and accept this. The gains in flood protection sought by this project are twofold. First, complete or nearly complete relief will be provided during the lesser storm events which currently are sufficient to inundate the area. Such storms may include everything from the semiannual through the ten year storm. For larger events, including coastal storms which produce storm surges overtopping East Broadway, the benefits resulting from this project will come in the form of more rapid drainage from the lower Great Creek basin into the Sound. Due to the 666% increase in discharge capacity, floodwaters can drain off during one tidal cycle following cessation of the storm compared to the several days which may be required at present. This will allow the residents to return to their normal living and working patterns much sooner. It will also yield dividends in the areas of safety and emergency access since roads will be passable more quickly following a storm.

Attempting to put dollar figures on the damages experienced and, therefore, the benefits to be realized at Great Creek is very difficult. No actual records of damages are kept. Even figures for Town expenses in connection with flooding, fire hazards or outlet maintenance are hard to come by, though estimates of the latter expenses were made and follow in this section.

Diversified Technologies sought to circumvent the lack of any concrete damage figures by using a damage-frequency curve developed by the Federal Emergency Management Administration (FEMA). Using these curves, values are derived for the damage produced by flooding to various depths. An annual damage cost of $727,500[15] was obtained for the homes, their contents, grounds, utilities and for non-physical losses (e.g. clean up costs, lost time at work, alternate accommodations). This figure seems very high and is not used here to cost justify the project. The high annual damage figure may, in part, be due to inputting average structure values which exceed the lower than average values of many of the more modest homes in the affected neighborhood.

Additional benefits will be derived from the peace of mind residents can enjoy with the reduced threat of flooding. Personal inconvenience in the lives of residents will also be reduced.

The reduced threat of flooding will also provide an incentive to make home and yard improvements which will increase the value of individual homes and improve the overall appearance of the neighborhood. Property values will increase both because

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[15] Diversified Technologies Corporation, Pre-design Report, Flood Control-Great Creek, Silver Sands State Park, Milford, Ct., 1983, p. 102.

the reduction in flooding will make the Great Creek neighborhood a more desirable place to live and because of individual and collective property and neighborhood improvements. This will benefit residents selling their homes and also benefit the City of Milford as the increased property values are reflected on the grand list and produce greater tax revenues.

Though not as important of a consideration as flood control, a second major benefit of this project will occur in the form of the restoration of the Great Creek marsh to an active salt marsh. The biologic gains from such a restoration are numerous but there are other areas which will yield bonus dividends. Such areas would include alleviation of a fire hazard, improved mosquito control, greater recreation potential and improved aesthetics.

Implementation of the project described will allow enhanced tidal flushing within the marsh. With standard tide gates which permit only outflow, restoration of the marsh would not be effected. However, the self-regulating tide gates incorporated into this project permit bidirectional flow. Twice each day incoming tides will have access to the marsh and can enter and cover the marsh. The amount of acreage covered each day will depend on the height of the high tide which varies with the lunar cycle. Nevertheless, the eventual result will be the loss of the dominant Phragmites cover and its replacement by characteristic salt marsh species, principally Spartina alterniflora, Spartina patens and Distichlis spicata. The resultant salt marsh will offer habitat to a much wider range of avian species as well as reintroducing marine and estuarine species including mussels, clams, oysters, crabs and shrimp. Both the range of species and the absolute number of individuals will be much greater in the restored marsh system. By comparison, the Phragmites environment offers only restricted habitat opportunities and a much lower overall productivity. This has been demonstrated at Pine Creek in Fairfield, where a similar restoration effort has been successfully undertaken.

Another value attached to the restoration of the Great Creek marsh to its original salt marsh state is the reduced danger of both nuisance and catastrophic fires. Again it is difficult to determine an average damage figure attributable to marsh fires.

The costs attached to the small nuisance fires, either accidental or intentional, stem from the expenses of the Milford Fire Department in dousing these blazes. While there are no records kept by the Fire Department, DTC has estimated a cost of $6,000 per event. This figure is based on a U.S. Army Corps of Engineers standard of $3,000 to $5,000 per marsh fire. However, as this standard is based on an area having roughly half as many homes as the Great Creek neighborhood, DTC considered a figure of $6,000 per event to be reasonable in this instance. They have also estimated a marsh fire frequency of 87 events in a 100 year period which equates to an annual cost figure of $5,220 in current dollars to combat such fires. This number is inclusive only of the municipal expenses to mobilize fire fighting men and equipment. It does not include damage to the structures.

Of greater consequence than the smaller more frequent fires is the ever present possibility of a catastrophic blaze which could cause the loss of many marshside homes. Phragmites is excellent fuel for a fire. In dry weather, especially with the current minimal inflow of tidal waters, the marsh can become a literal tinderbox capable of spreading a blaze with alarming speed. Even under less than ideal conditions, the dried canes of the previous year's growth represent a potent fuel supply for any flame which can take hold. Fires in this and other similar Phragmites beds are frequent enough that the possibility of a fire getting out of control is a very real threat. Given the extreme proximity of the homes at Great Creek to the marsh, it is a very fortunate thing that a seriously destructive fire has not yet had the chance to do its damage.

After a successful conversion of the Great Creek marsh to salt marsh species, the fire danger will be greatly reduced. First of all, Spartina species do not constitute a fire hazard because they do not offer the same fuel value. Neither Spartina alterniflora nor Spartina patens develop any persistent woody cane structure. Both decompose much more quickly than Phragmites. Secondly, the increased tidal inflow will saturate the marsh twice daily thus insuring perpetually moist conditions, even during periods of prolonged dry weather. This will make it much more difficult for a fire to start and for any fire, once started, to propagate itself. Thus, with a greatly reduced fuel supply and less favorable conditions for combustion, the existing threat of fires is defused.

Similarly reduced will be the mosquito breeding potential of the marsh. Fresh and/or brackish water mosquitos currently breed in the marsh at sufficient levels that they pose an annoyance to local residents. This is made possible by the numerous stagnant pools which form and eventually dissipate yielding ideal conditions for mosquito production. The lack of flushing and the temporary nature of the stagnant pools have made past mosquito control efforts less than successful.

Mosquito control efforts will be benefitted by the diurnal rinsing of the marsh by the incoming tidal flows. This flushing will operate to eliminate stagnant water conditions critical to egg laying and to avoid the later drying period so necessary for larvae development. The salinity increase will also work to the detriment of the existing freshwater or brackish water mosquitos in the marsh. Additionally, the reduction of the Phragmites cover will facilitate mosquito control efforts by providing easier access into the marsh for control operations and by exposing breeding pools to aerial spraying.

It is probable that salt marsh mosquitos will move into the created niche, probably occupying areas of high salt marsh around the periphery of the system. Areas of likely concentration would be those inundated only by the spring high tides. If, and to the extent that this problem may develop, control of salt marsh mosquitos is a much easier problem to deal with. Open marsh water management techniques have been highly successful at significantly reducing salt marsh mosquito population levels in other areas. Therefore, at best we can expect to substantially solve the existing mosquito problem while at worst, we will swap the current difficult mosquito management problem for a battle we are much more likely to win.

One final benefit arising form the marsh restoration will be the aesthetic improvement. Fields of waving marshgrass represent a major visual improvement as compared to acres of dead, continuous, impenetrable Phragmites stalks. The additional bird life which will inhabit the salt marsh will also provide eye- and ear-appealing amenities which will afford birders and casual observers extra viewing or recreational opportunities.

Elimination of the existing clog-prone outlet works of the creek will result in a savings to the City of Milford as public works crews need not be regularly dispatched to clean out the pipe and channel. The Public Works Department estimates the annual expense for channel maintenance at $10,000. Of course, the new outlet works will require some reduced level of maintenance periodically. Therefore, the net savings realized will be somewhat less than $10,000.

APPENDIX A

THE DEVELOPMENT AND FUNCTION OF THE SELF-REGULATING TIDE GATE

The self-regulating tide gate is a structure, generally used in conjunction with a drainage structure such as a metal or concrete pipe, to manage the flow of tidal water into a small cove or tidal marsh system. Unlike conventional tide or flapper gates, which when functioning, only permit unidirectional flow through a culvert or other drainage structure, the self-regulating tide gate permits bidirectional flow. That means that during an ebbing tide, water can flow from the marsh seaward into the Sound or adjacent tidal water body and during a flood tide, the water can move unimpeded back into the marsh. It therefore allows the marsh to be subject to a more or less natural regime of tidal flooding. Conventional gates on the other hand, usually permit drainage of excess waters from the marsh into the Sound during an ebbing tide but, on a rising or flood tide, will not permit tidal salt water to enter into the marsh.

Conventional tide gates as noted above only permit unidirectional flow when properly functional. Along the Connecticut coast, most of these gates were installed during the 1920's to the 1940's for the purposes of controlling mosquitoes. In general, the environmental changes that occur to a salt marsh located landward of one of these structures is as follows:

1. There is a partial or complete elimination of all tidal inflows to the marsh.
2. Concurrently, the water table in the marsh can drop usually on the order of 2' to 3' and the salt water content of soil and creek water will diminish and at times become entirely fresh in nature. In some areas, the potential lowest elevation of the water table corresponds to the lowest elevation of the culvert to which the tide gate is attached.
3. The marsh peat often 'subsides' to a level which can be lower than neighboring healthy marsh systems by one to two feet. This phenomenon may simply be a function of greater aeration in the surface soil resultant to the lowering of the water table. This in turn accelerates the decomposition rates of the organic material in the soil.
4. These environmental conditions represent optimum habitat for an aggressive albeit indigenous grass called reed (*Phragmites australis*). This grass will displace native salt marsh grasses and ultimately form a monoculture that stands 5' to 8' tall. Reed also transpires large volumes of water and may be a contributing factor to the lowering of the water table.

These changes also culminate in a number of social problems. First, wherever reed becomes established and abundant, it poses a potential and serious fire hazard. Since reed does not decompose readily, any marsh can quickly accumulate large volumes of combustible materials that can burn quickly and produce a very hot fire. In the town of Fairfield, the reed marshes, formerly healthy salt marshes, became a recurrent fire hazard that not only resulted in annual damage losses to homes, appurtenant structures and automobiles, to name but a few, but the town also incurred an annual cost of approximately $30,000 to fight and contain these fires. Secondly, drainage creeks, ditches and structures accumulated sediment due to poor flushing rates, thereby necessitating periodic maintenance and cleaning. Incidental to this, during inland storms, the presence of clogged structures would cause stormwater to back up and flood streets and property. Last, but not least, the capacity to harvest some of the natural resources such as fish and crabs was eliminated as the area degraded. The sea of reed also results in the loss of once majestic vistas and probably contributes to lower property values.

In the town of Fairfield, structures in certain flood prone coastal areas were floodproofed by the construction of earthen dikes. Into the dikes were installed conventional tide gates which would allow stormwater to drain into the Sound, at least when the tide gates were operative. In certain areas, this protection against coastal flooding increaseed the level of inland flooding. All of the degraded marshes became fire hazards. In an effort to resolve these problems and to restore the social and biological values of these marsh areas, the Conservation Director, Mr. Thomas Steinke, devised the self-regulating tide gate.

The concept of the self-regulating tide gate is a fairly simple one. Installation of a self-regulating tide gate permits the reintroduction of tidal flows and salt water. The elevation of the water table increases as does the salt content. These two factors alone contribute to arresting the spread of reed and actually inducing the re-establishment of salt marsh vegetation. This is a gradual process since reed is so tenacious in certain areas that restoration of tidal flows sometimes needs to be augmented by physical control of reed.

Usually, the re-establishment of normal tidal flows does not threaten property or structures with tidal flooding. However, where elevated storm tides are a major concern and problem, self-regulating tide gates can incorporate a feature which allows for control during storm events. Attached to the gates are a set of floats that can be adjusted to a specified level to prohibit the introduction of flood waters. When the incoming tide reaches this elevation, the gate closes. In this manner, restoration of salt marsh can occur and flood protection can be provided to land surrounding the marsh.

Through the years, the self-regulating tide gate has undergone numerous modifications and improvements. The present design, which has been functioning for 3 years, appears to be very reliable. Tidal flooding has been controlled and the marshes receive adequate volumes of tidal water to facilitate restoration of salt marsh. Where conventional gates can fail due to flotsam, boats or mattresses, to name a few, preventing the gate from closing, the self-regulating tide gate never becomes locked open with debris. Also, in the event of the coincidence of a major coastal storm and inland storm, the self-regulating tide gate can be manually locked closed at low tide to increase the flood storage area in the marsh. The marsh can accommodate more storm water without causing flooding due to the combination of these two storm events.

APPENDIX B

MARSH RESTORATION AT GREAT CREEK

Historical Persective

Figure 2 depicts the nature and extent of the marshes in the vicinity of Myrtle and Silver Sands beaches in the 1800's. At that time, the system was complex and was comprised of approximately 300 acres. There were two primary inlets located at either end of a barrier beach. The eastern one was Great Creek located between Fort Trumbull and Silver Beaches. The second was Fletchers Creek located at the southeastern end of Silver Beach. Both of these discharged across a wide sand flat located southeast of the beaches. At the eastern end of Myrtle Beach was a third small tidal creek which supplied tidal water to the westernmost area of this complex.

The Great Creek system was separated from Long Island Sound by three barrier beaches, namely Fort Trumbull Beach, Silver Beach and Myrtle Beach. Between Myrtle Beach and Silver Beach, there was no barrier beach but simply a series of discontinuous sandy ridges. This may have been a function of 1) the absence of an adequate sand supply at this location historically 2) the protection afforded to this area by Charles Island and the bar preventing the formation of a large barrier or 3) the wave refraction induced by the location of Charles Island concentrating wave action at this site and inducing erosion. Even today, this area supports little if any barrier and is prone to erosion.

The width of Great Creek at the juncture of the two barrier beaches only measured approximately 20'. Despite this small width and the even smaller widths of the other two creeks, adequate tidal flows were provided to the marsh for it to remain mostly salt marsh. Although the creeks crossed an expanse of active sandflat, the creeks were self-maintaining.

Degradation of the Great Creek System

Since the turn of the century, a number of activities have contributed to the degradation of the Great Creek system. These include filling to accommodate roads such as East Broadway and structures such as residential cottages and the use of the area for landfill operations. The latter evidently was the largest single filling operation with the greatest effect on the salt marsh.

The culvert that presently provides the connection between the marsh and Long Island Sound reduced the original creek width by 80%. Further, the tide gate that is located in the manhole in this line along with sediment that has accumulated in the pipe has significantly reduced tidal flows to the Great Creek marsh.

This structure historically has caused the following changes or impacts to the marsh:

1. The reduction in tidal flow has induced a lowering of the water table and a decline in salinity levels.
2. Lowering of the water table has improved the soil aeration and hence the decomposition rates of the organic soil in this marsh. This in turn may have resulted in the 'subsidence' of the peat.
3. Resultant to the lowering of the water table and the reduction in soil salinity, the tall grass reed (Phragmites australis) became a pestiferous weed and displaced indigenous salt marsh grasses and plants.
4. The small cross-sectional area of the culvert has a limited capacity to transmit stormwater to the Sound and therefore backflooding problems were created when the system was installed. Backflooding has been exacerbated by the degraded condition of the tide gate and the sediment accumulation in the pipe.

The environmental changes that have occurred from the installation of tide gates and an undersized culvert in Great Creek have been responsible for the indirect degradation of the Great Creek salt marshes. With the conversion of this salt marsh to a reed dominated marsh, degradation in wildlife productivity has also occurred. Unarguably, backflooding is a very real problem to low lying residences located at the perimeter of the marsh. However, while flooding does create some inconveniences and inflicts damage on property and structures, of equal or greater import is the tremendous fire hazard created by the dense stands of reed. Based upon the experiences in the Town of Fairfield and other coastal towns where dense colonies of reed occur, fires are a very real and costly problem. These include the loss of structures, landscape plants, appurtenant structures and automobiles, to name a few. Additionally, there are the added costs to the residents and the town to fight and contain marsh fires and to cut fire breaks.

Mosquito Ditch Jurisdiction and Maintenance

In 1936, Botsford[16] reported that the Silver Beach area (presumably all of this salt marsh system) had been ditched and drained through state-wide projects sponsored by the WPA program. It is necessary to digress at this point to address a question of

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[16] R.C. Botsford, Present Status of Mosquito Control Work in Connecticut, Connecticut Experiment Station, Bulletin 383, 1936, p. 299.

jurisdiction. The structure of the State's mosquito control effort was to accept the responsibility for maintaining mosquito ditches and structures only after a town had secured its own funding to have mosquito control activities conducted in that town. If the marsh was in good condition following the mosquito control practices, usually ditching, then the State's mosquito control program accepted jurisdiction over the long term maintenance of those marshes. However, the State's mosquito control program never accepted maintenance of those areas where the mosquito control actions were initiated under the WPA program (almost all of these were conducted in towns which had not by that date ditched their marshes). Today therefore, Milford is a town in which the Mosquito Control Division of the Connecticut Department of Health Services does not accept jurisdiction or responsibility for any mosquito control actions or related structures.

In the report referenced above, there is documentation of the replacement of existing tide gates, building of two tide gate manholes, installation of three culverts and replacement of one culvert. This report not only indicates that tide gates were present prior to 1935, but also that the replacement was conducted under the WPA program. Subsequent to WPA projects like this one, the Mosquito Control Division applied multiple times to the Connecticut Legislature to manage and maintain these additional areas. Funding was never appropriated and responsibility to maintain the ditches in this marsh and any associated structures was never accepted by the Mosquito Control Division.

Restoration of the Marsh

Degraded wetlands such as this can be restored through the re-establishment of tidal flushing. Such restoration projects have been successfully undertaken at Pine Creek in Fairfield and Barn Island in Stonington. Another is being planned at Ash Creek in Fairfield. The elevated tidal levels and salt content of the soil reduce the vigor of reed and ultimately induce the replacement of reed by salt marsh vegetation. In this system, to restore salt marsh will require the reintroduction of sufficient quantities of salt water which will periodically inundate most of the marsh surface at least twice a month. This will require a drainage structure such as a culvert or a series of culverts which provide a significantly greater cross-sectional area than the present culvert does. Also a larger cross sectional area will facilitate faster dewatering of the marsh during inland storms. Coastal flood control can be achieved through various means but perhaps the best in this case would be a series of self-regulating tidal gates. In this manner, the salt marsh can be restored, backflooding can be reduced or entirely eliminated and tidal flooding during extreme storm tides can be controlled.

APPENDIX C

RESULTS OF FLORA AND FAUNA SURVEY

The following tables, maps and text are excerpted from a report entitled Final Environmental Report, Great Creek Flood Control Project, Silver Sands State Park, Milford, Connecticut (June 1983) prepared by Dr. Karl Eric Tolonen as a part of the research for Diversified Technologies Corporation's Pre-design Report. The species tables are reproduced in their entirety. Maps and text are included sufficient to locate the sampling sites and explain the rationale for their selection.

The Great Creek area of Silver Sands State Park, Milford, Connecticut, has been subject to flooding problems for some time. The author of this report has visited the site twelve times to gather various environmental data, which are to be used in assistance of the engineering design of flood-alleviation measures. This is the final report of findings, all laboratory analyses having been completed. It should be noted that the project timetable required field work during the winter. The potential impact of this is discussed within each section dealing with the findings of the field investigations below. This final report incorporates responses to all questions and comments received relating to the Revised Preliminary Report (ref. 1). In this report, "northern" refers to the area along Mayflower Place, "western" refers to the area along Nettleton Avenue, "southern" refers to the East Broadway area, and "eastern" refers to areas along Surf Avenue.

VASCULAR VEGETATION

I have taken six collections of vascular vegetation and have made additional observations of vegetation at other sites representing primarily the wetland areas of the Park (Figure 1, Tables 1 - 7). The scope of this study was limited to understanding potential impact of drainage alterations on the Park's wetland habitats.

Tables 1 through 6 contain lists of plants collected and identified at the sampling points marked on Figure 1. Because of the condition of the vegetation at this time of year (January - March), most collections contained some unidentifiable specimens. Also, most herbaceous species had not yet appeared, so the plant list is much shorter that would be expected were the work done during the summer. It should be noted that *Phragmites australis* is present throughout the Park; I collected only one specimen for verification (Table 1). Although a variety of sources were used for identifying specimens, all terminology in Tables 1 - 6 follows Dowhan (ref. 2).

The major wetland units identified are an extensive *Phragmites* marsh occupying much of the Great Creek area, and a series of freshwater wetlands (marsh, swamp, pond, and stream types) along the northern and western boundaries of the Park. Collection M1-V (Table 1) is typical of the upland fringe of the marsh, with some wetland species and some drier habitat ones. M2-V (Table 2) was selected to represent maximal saltwater influence. Even at this station, true saltmarsh species are overshadowed by *Phragmites*, with *Spartina* limited to a narrow fringe along the Creek. The remaining 4 stations represent the freshwater wetlands along the northern and western boundaries. Stations M3-V, M5-V and M6-V support a high diversity of of wetland plants, many of them of considerable value to wildlife (examples: Acer, Alnus, Cornus, Elaeagnus, Lindera, Quercus, Rhus, Sambucus, Toxicodendron, Viburnum) Songbirds were notably abundant at these sites. Collection M4-V comes from the drainage channel along Nettleton Avenue. This channel is now dominated by Phragmites, but was mapped as Typha (cat-tail) by Geraghty & Miller, Inc. (ref. 3). Other than this change, the vegetation of the Park is essentially as shown on their map.

No plant collections were made at the following stations, but all were dominated by Phragmites: M12-A and M13-A on Surf Avenue; M22-C; M15-A, M20-C and M21-C near James Street; the large depression west of Cooper Avenue; and the area of Fletcher's Creek.

Plant species are used in Section 22a-29 as part of the legal definition of "Tidal Wetlands", and several of these species occur within the Park (Table 7). I would expect a more detailed vegetation study, during the summer, to find more than 20 of these species (from Section 22a-29) within the Park. Most of them are herbaceous, so would be unlikely to be found in March when most plant collecting was done.

SUMMARY-VASCULAR VEGETATION:

1) Most of the site is dominated by Phragmites. See following section "PRESENT CONDITION" for a detailed discussion of this plant.
2) The freshwater wetlands along the northern and western Park boundaries have considerable diversity and value for wildlife.
3) Although presently regulated as an Inland Wetland, the site could be classified as a Tidal Wetland, based on the vegetation.

Figure 1. Sampling points for vegetation. IIA)

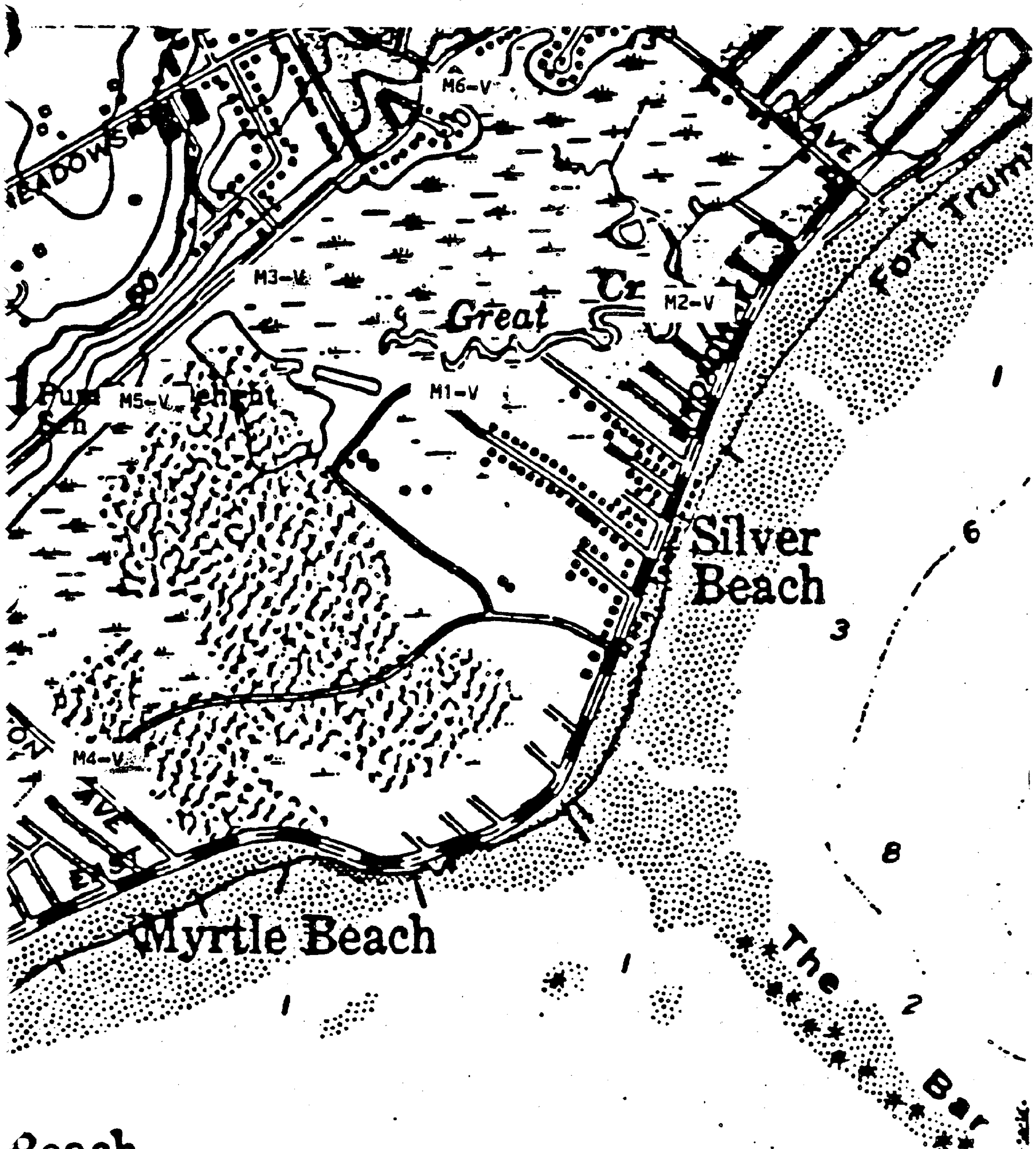
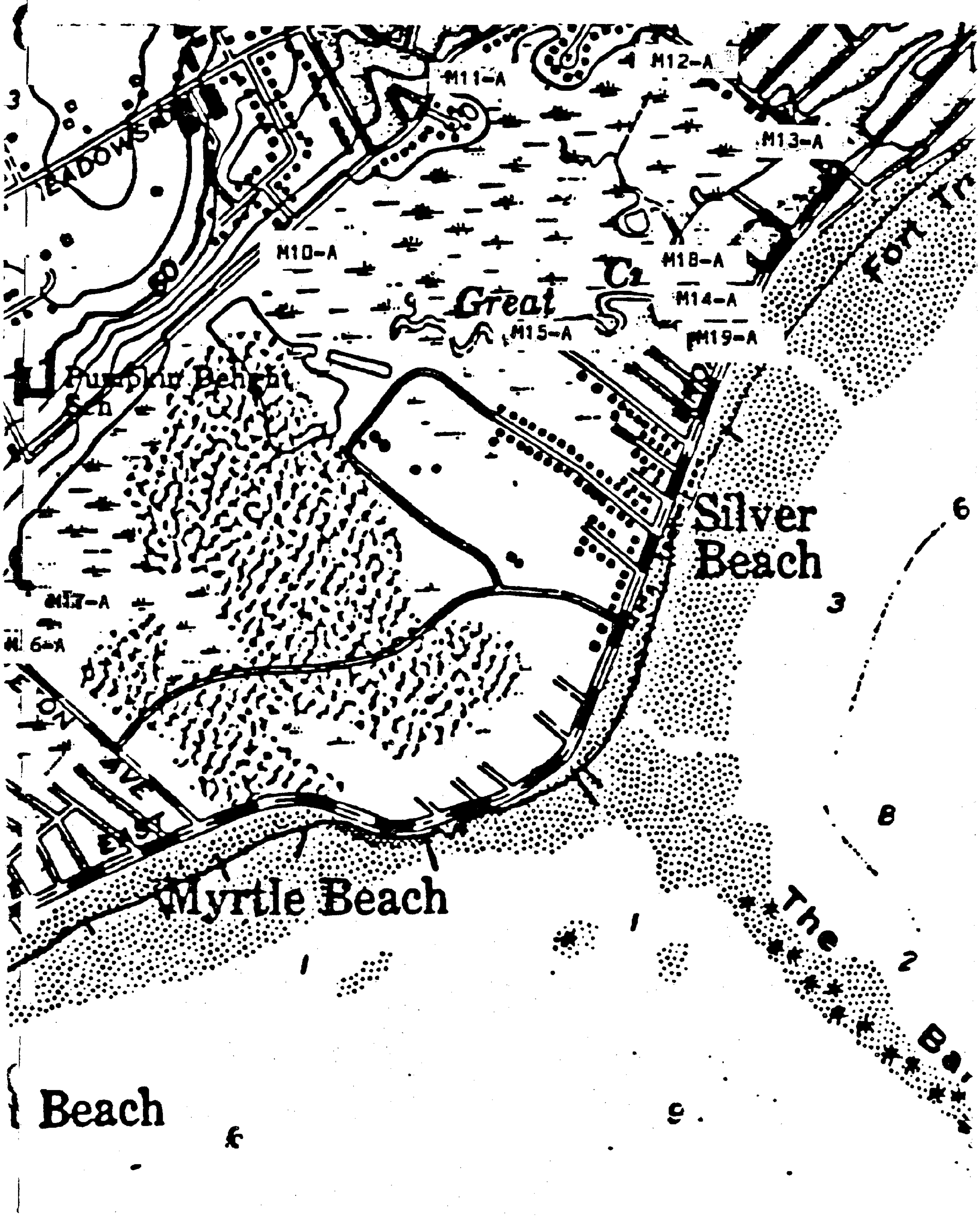


Figure 2. Sampling points for aquatic organisms.



Collection M1-V	VASCULAR VEGETATION	3 January 1983
Family:	Taxon collected:	
Anacardiaceae	*Rhus glabra*	
Bignoniaceae	*Catalpa* sp.	
Compositae	probably *Centaurea*	
Compositae	Genus ?	
Cucurbitaceae	*Echinocystis lobata*	
Fagaceae	*Quercus* sp.	
Gramineae	*Panicum* sp.	
Gramineae	**Phragmites australis*	
Phytolaccaceae	*Phytolacca americana*	
Polygonaceae	probably *Reynoutria* sp.	
Scrophulariaceae	probably *Linaria* sp.	

*This species present throughout the Park; collected only at this station.

Note: On Tables 1-17, a "?" indicates uncertainty of identification.

Collection M2-V — VASCULAR VEGETATION — 3 January 1983

Family:	Taxon collected:
Gramineae	*Spartina alterniflora*

(Most vegetation at this site is *Phragmites*.)

Collection M3-V	VASCULAR VEGETATION	3 January 1983 & 26 March 1983
Family:	Taxon collected:	
Aceraceae	Acer rubrum	
Araceae	Symplocarpus foetidus	
Berberidaceae	Berberis sp.	
Caprifoliaceae	Lonicera, probably japonica	
Caprifoliaceae	Sambucus canadensis	
Caprifoliaceae	Viburnum sp.	
Celastraceae	Celastrus orbiculatus	
Clethraceae	Clethra alnifolia	
Compositae	Arctium sp.	
Corylaceae	Alnus, probably rugosa	
Corylaceae	Alnus, probably serrulata	
Ericaceae	Rhododendron (Azalea) viscosum?	
Gramineae	Genus ?	
Labiatae	Genus ?	
Lauraceae	Lindera benzoin	
Liliaceae	Smilax sp.	
Moraceae	probably Morus sp.	
Polygonaceae	probably Rumex sp.	
Rosaceae	Rosa sp.	
Rosaceae	Rubus sp.	
Salicaceae	Salix sp.	
Vitaceae	Parthenocissus quinquefolia	
Vitaceae	Vitis sp.	

(The stream south of Pilgrim Lane is lined primarily by Phragmites.)

Collection M4-V	VASCULAR VEGETATION	3 February 1983
Family:	Taxon collected:	
Malvaceae	*Hibiscus palustris*	

(*Phragmites* is dominant vegetation lining drainage ditch.)

Collection MS-V	VASCULAR VEGETATION	26 March 1983
Family:	Taxon collected:	
Aceraceae	*Acer negundo*	
Aceraceae	*Acer rubrum*	
Anacardiaceae	*Rhus typhina*	
Anacardiaceae	*Toxicodendron radicans*	
Anacardiaceae	*Toxicodendron vernix*	
Araceae	*Symplocarpus foetidus*	
Caprifoliaceae	*Lonicera japonica*	
Caprifoliaceae	*Sambucus canadensis*	
Caprifoliaceae	*Viburnum*, probably *recognitum*	
Celastraceae	*Euonymus alatus*	
Cornaceae	*Cornus florida*	
Cornaceae	*Cornus* sp., not *florida*	
Compositae	Genus 1?	
Compositae	Genus 2?	
Corylaceae	*Alnus*, probably *rugosa*	
Corylaceae	*Carpinus caroliniana*	
Elaeagnaceae	*Elaeagnus* sp.	
Ericaceae	*Vaccinium* sp.	
Fagaceae	*Quercus* sp.	
Iridaceae	probably *Iris* sp.	
Lauraceae	*Lindera benzoin*	
Lauraceae	*Sassafras albidum*	
Liliaceae	*Allium* sp.	
Magnoliaceae	*Liriodendron tulipifera*	
Malvaceae	*Hibiscus palustris*	
Onagraceae	*Oenothera* sp.	
Polypodiaceae	*Onoclea sensibilis*	
Rosaceae	*Rosa* sp.	
Rosaceae	*Rubus* sp.	
Rosaceae	*Spiraea latifolia*	
Salicaceae	*Salix* sp.	
Scrophulariaceae	probably *Chelone*	
Typhaceae	*Typha latifolia*	
Urticaceae	*Boehmeria cylindrica*	
Vitaceae	*Vitis* sp.	

Y: DR. KARL ERIC TOLONEN

Collection M6-V VASCULAR VEGETATION 26 March 1983

Family:	Taxon collected:
Aceraceae	Acer rubrum
Anacardiaceae	Toxicodendron vernix
Araceae	Symplocarpus foetidus
Berberidaceae	Berberis sp.
Caprifoliaceae	Lonicera japonica
Caprifoliaceae	Sambucus canadensis
Caprifoliaceae	Viburnum recognitum
Compositae	Arctium sp.
Convolvulaceae	Cuscuta sp.
Corylaceae	Alnus, probably serrulata
Corylaceae	Betula lenta
Corylaceae	Betula populifolia
Cucurbitaceae	Echinocystis lobata
Fagaceae	Fagus grandifolia
Fagaceae	Quercus, probably bicolor
Gramineae	Genus ?
Iridaceae	probably Iris sp.
Lauraceae	Lindera benzoin
Liliaceae	Allium sp.
Liliaceae	Smilax rotundifolia
Polygonaceae	Rumex sp.
Rosaceae	Rosa sp.
Rosaceae	Rubus sp.
Salicaceae	Salix sp.
Vitaceae	Parthenocissus quinquefolia

TIDAL WETLAND SPECIES: SECTION 22a-29

X *Acer rubrum*
X *Alnus rugosa* (probable identification)
X *Alnus serrulata* (probable identification)
X *Clethra alnifolia*
X *Cornus*, species not determined
X *Hibiscus palustris*
X probably *Iris*
X *Onoclea sensibilis*
X *Panicum*, species not determined
X *Rhododendron viscosum* (probable identification)
X "*Rhus*" *radicans*
X "*Rhus*" *vernix*
X *Rosa*, species not determined
X *Spartina alterniflora*
X *Symplocarpus foetidus*
X *Typha latifolia*
X *Vaccinium*, species not determined

Collection M10-A AQUATIC ORGANISMS 13 March 1983

Count:	Taxon collected:
1	Turbellaria
3	Annelida: Hirudinea
15	Annelida: Oligochaeta
26	Amphipoda: Gammaridae: Gammarus
4	Insecta: Diptera: Chironomidae
1	Mollusca: Gastropoda: Physidae: Physa

50 = TOTAL NUMBER OF SPECIMENS

Collection M11-A AQUATIC ORGANISMS 13 March 1983

Count:	Taxon collected:
8	Annelida: Oligochaeta
1	Crustacea: Isopoda: Asellidae
1	Insecta: Diptera: Tipulidae
10 = TOTAL NUMBER OF SPECIMENS	

(Also collected 4 non-aquatic millipedes from stream.)

Collection M11-A, repeat visit on 24 May 1983:

No aquatic organisms found in 4 samples taken in stream.

Collection M12-A AQUATIC ORGANISMS 13 March 1983

Count:	Taxon collected:
4	Osteichthyes: Cyprinodontidae: *Fundulus* sp.

4 = TOTAL NUMBER OF SPECIMENS

FINAL REPORT	SILVER SANDS STATE PARK	TABLE 11
Collection M13-A	AQUATIC ORGANISMS	13 March 1983

Count:	Taxon collected:
26	Crustacea: Palaemonidae: *Palaemonetes pugio*
1	Osteichthyes: Gasterosteidae: *Gasterosteus aculeatus*

27 = TOTAL NUMBER OF SPECIMENS

Collection M14-A   AQUATIC ORGANISMS   13 March 1983

Count:	Taxon collected:
1	Polychaeta: Nereidae: _Nereis_?
47	Crustacea: Balanidae: _Balanus_ sp.
3	Crustacea: Palaemonidae: _Palaemonetes pugio_
1	Crustacea: Portunidae: _Carcinus maenas_
13	Mollusca: Gastropoda: Nassariidae: _Nassarius obsoletus_
2	Mollusca: Bivalvia: Mytilidae: _Modiolus demissus_
1	Mollusca: Bivalvia: Mytilidae: _Mytilus edulis_
3	Mollusca: Bivalvia: Ostreidae: _Crassostrea virginica_
1	Osteichthyes: Gasterosteidae: _Gasterosteus aculeatus_
7	Osteichthyes: Cyprinodontidae: _Fundulus_ sp.
79 = TOTAL NUMBER OF SPECIMENS	

Collection M15-A — AQUATIC ORGANISMS — 13 March 1983

Count:	Taxon collected:
1	Polychaeta: Capitellidae?
1	Polychaeta: Nereidae: *Nereis*?
6	Crustacea: Amphipoda: *Corophium*?
9	Crustacea: Amphipoda: Gammaridae
28	Crustacea: Palaemonidae: *Palaemonetes pugio*
2	Osteichthyes: Anguillidae: *Anguilla rostrata*
2	Osteichthyes: Cyprinodontidae: *Fundulus* sp.

49 = TOTAL NUMBER OF SPECIMENS

Collection M16-A   AQUATIC ORGANISMS   13 March 1983

Count:	Taxon collected:
20	Annelida: Oligochaeta
1	Insecta: Odonata: Coenagrionidae
1	Insecta: Odonata: Libellulidae
1	Insecta: Hemiptera: Corixidae
4	Insecta: Coleoptera: Dytiscidae (larvae)
7	Insecta: Coleoptera: Dytiscidae (adults)
2	Insecta: Coleoptera: Haliplidae (adults)
1	Insecta: Trichoptera
1	Insecta: Diptera: Ceratopogonidae
25	Mollusca: Gastropoda: Physidae?
63 = TOTAL NUMBER OF SPECIMENS	

Collection M17-A AQUATIC ORGANISMS 13 March 1983

Count:	Taxon collected:
11	Insecta: Hemiptera: Corixidae
133	Insecta: Diptera: Chironomidae

144 = TOTAL NUMBER OF SPECIMENS*

*NOTE: Picked through several subsamples of a large collection and counted. Remaining specimens were discarded. The entire collection was scanned and only these two taxa were seen.

Collection M18-A — AQUATIC ORGANISMS — 25 March 1983

Count:	Taxon collected:
3	Mollusca: Gastropoda: Nassariidae: *Nassarius obsoletus*
1	Mollusca: Bivalvia: Veneridae: *Mercenaria mercenaria*
1	Osteichthyes: Cyprinodontidae: *Fundulus* sp.
5 = TOTAL NUMBER OF SPECIMENS	

Also found empty tube probably belonging to *Pectinaria* (Polychaeta: Pectinariidae) and fresh, but empty shell of *Busycon* (Gastropoda).

NOTE: No table given for Collection M19-A, 13 March 1983, as no aquatic organisms were collected (See text.).

BIRD LIST

Family:	Species (or genus):	Common name:
Accipitridae	Circus cyaneus	Northern Harrier
Alcedinidae	Megacervle alcyon	Belted Kingfisher
Anatidae	Anas platyrhynchos	Mallard
Ardeidae	Butorides striatus	Green Heron
Charadriidae	Charadrius vociferus	Killdeer
Columbidae	Zenaida macroura	Mourning Dove
Corvidae	Corvus brachyrhynchos	American Crow
Corvidae	Cyanocitta cristata	Blue Jay
Falconidae	Falco sparverius	American Kestrel
Fringillidae	Cardinalis cardinalis	Northern Cardinal
Fringillidae	Carpodacus mexicanus	House Finch
Fringillidae	Melospiza melodia	Song Sparrow
Fringillidae	Spizella arborea	American Tree Sparrow
Hirundinidae	Hirundo rustica	Barn Swallow
Icteridae	Agelaius phoeniceus	Red-winged Blackbird
Icteridae	Euphagus sp.	blackbird sp.
Icteridae	Quiscalus quiscula	Common Grackle
Laridae	Larus argentatus	Herring Gull
Laridae	Larus delawarensis	Ring-billed Gull
Laridae	Larus marinus	Greater Black-backed Gull
*Mimidae	Mimus polyglottos	Northern Mockingbird
Picidae	Colaptes auratus	Common Flicker
Scolopacidae	Tringa melanoleuca	Greater Yellowlegs
Sturnidae	Sturnus vulgaris	European Starling

MAMMAL LIST

Cricetidae	Ondatra zibethicus	Muskrat
Sciuridae	Sciurus carolinensis	Eastern Gray Squirrel

*Add: Paridae	Parus atricapillus	Black-capped Chickadee

APPENDIX D

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

Coastal Management Consistency
Review Worksheet

- Supplemental Evaluation for Projects Located Within the Coastal Boundary

Refer to coastal management consistency review instructions (attached) for sources of information and instructions for filling out this review worksheet.

I. Description of the Proposed Project

A. Briefly describe the entire project including its location, setting, purpose and component activities (i.e., site alterations and improvements, proposed buildings, type of use, etc.).

Drainage improvement project to provide flood protection to residences along and north of East Broadway, west of Surf Ave. and south of Great Creek Marsh consisting of diversion of Great Creek westerly from the existing confluence of the east and west branches to outlet into Long Island Sound near the intersection of East Broadway and the Silver Sands Road. The diversion will be routed through man-made open channel and box culvert with an open channel outlet. The existing Great Creek outlet will be filled. (See Proposed Great Creek Flood Protection Plan-page 27)

II. Project Location

A. Location Description: as applicable

coastal boundary map quad (U.S.G.S. map quad) Milford

location of activity site (including street address, names of roads in vicinity of site, etc.)

Great Creek Marsh, its existing outlet, eastern end of Silver Sands State Park, East Broadway

(See Project Setting - page 4)

name(s) of waterway(s) on or adjacent to the site

Great Creek, Long Island Sound

III. Determination of Coastal Management Policies' Applicability and Consistency.

A. Identify any and all coastal use policy categories (as reprinted in CAM Planning Report No. 30, Sections II-A to II-P) corresponding to all activities and uses associated with the proposed project.

COASTAL USE POLICY CATEGORIES

X II-A. General Development

___ II-B. Water Dependent Uses

___ II-C. Ports and Harbors

X II-D. Coastal Structures and Filling

X II-E. Dredging and Navigation

___ II-F. Boating

___ II-G. Fisheries

X II-H. Coastal Recreation & Access

COASTAL USE POLICY CATEGORIES

___ II-I. Sewer and Water Lines

___ II-J. Energy Facilities

___ II-K. Fuel, Chemicals & Hazardous Mat

___ II-L. Transportation

___ II-M. Solid Waste

___ II-N. Dams, Dikes and Reservoirs

___ II-O. Cultural Resources

___ II-P. Open Space & Agricultural Lands

B. Identify any and all coastal resource policy categories (as reprinted in CAM Planning Report No. 30, Sections I-A to I-N) for all resources on and adjacent to the proposed site and affected by the proposed activity.

RESOURCE POLICY CATEGORIES	On Site	Adjacent To Site	Affected by Activity	Not Applica
I-A. General Resources	X		X	
I-B. Bluffs or Escarpments				X
I-C. Rocky Shorefronts				X
I-D. Beaches or Dunes	X		X	
I-E. Intertidal Flats	X		X	
I-F. Tidal Wetlands	X		X	
I-G. Freshwater Wetlands/Watercourse	X		X	
I-H. Coastal Hazard Areas				
Flood Hazard	X		X	
Erosion Hazard	X		X	
I-I. Developed Shorefront	X		X	
I-J. Islands		X		
I-K. Shorelands				X
I-L. Shellfish Concentration Areas		X	X	
I-M. Coastal Waters				
Nearshore Waters	X		X	
Offshore Waters				X
Estuarine Embayments				X
I-N. Air Resources and Air Quality	X		X	

C. Identify any and all government process policies as reprinted in CAM Planning Report No. 30, Sections III-A to III-F for all government processes associated with the proposed project.

GOVERNMENT PROCESS CATEGORIES

X III-A. Intergovernmental Coordination of Planning and Regulatory Activities.

X III-B. Coordination and Consistency of State Programs, Projects, Expenditures and Acquisitions.

X III-C. Flooding and Erosion Planning

____ III-D. Dredging and Dredged Material Disposal Planning

____ III-E. Coastal Related Research

____ III-F. National Interest Facilities and Resources

D. Determine if the proposed project is consistent with all of the coastal policies within the categories identified in III(A), (B) and (C) above. (List each policy under the appropriate column heading.) Note: If a project conflicts with any policy, the project should be modified to reduce or eliminate the conflict. Refer to specific policies as lettered in Planning Report No. 30 within each applicable category (e.g., III-A.A, B, C, etc.).

	Consistent	Inconsistent	Not Applicable to This Project
Use Policies	II-A.A II-D.A,C,E,F II-E.E		II-A.B,C II-D.B,D II-E.A,B,C,D,F
Resource Policies	I-A.A,B,C,D I-D.A,D I-E.E I-F.A,B,D I-G.A,B I-H.A,B,C,E,F,G,I		I-D.B,C I-E.A,B,C,D I-F.C,E I-H.D,H I-I.A I-L.A,B,C,D I-M.A,B,C,D I-N.A,B
Government Process Policies	III-A.A III-B.A,B,C,D III-C.A		III-B.E

IV. Evaluation of the Potential Adverse Impacts of the Project and Description of Proposed Methods to Mitigate Adverse Effects.

A. Identification of Potential Adverse Impacts.

	NONE/MINOR	MODERATE	SIGNIFICANT
Tidal Wetlands	-		
Beaches	X		
Dunes	-		
Rocky Shorefront	-		
Bluffs and Escarpments	-		
Wildlife	X		
Finfish	X		
Shellfish	X		
(include impacts on habitat, breeding, feeding, nursery areas and migratory route			
Coastal Flooding	X		
Surface Water Drainage	X		
Coastal Water Circulation	X		
Groundwater Quality	X		
Surface Water Quality	X		
Coastal Water Quality	X		
Visual Quality		X	
Other			

B. Briefly describe and evaluate the potential adverse impacts identified above as moderate or significant and the proposed measures to mitigate any adverse impacts. Explain why any remaining adverse impacts were not mitigated

The visual impact of erecting timber training walls crossing the existing sandy beach could be considered to be moderately significant. There are, however, existing structures crossing nearby stretches of beach such as th groins in the State Park and the timber training walls, very similar to those proposed, at the end of Nettleton Ave. A lower profile structure suc as a twin stone groin would result in significantly greater construction costs.

V. Determination

Policies:	X	Consistent		Inconsistent
Adverse Impacts:	X	Acceptable		Unacceptable

Comments:

APPENDIX E

REVISED COST FIGURES OF APRIL 1984

The following pages provide a detailed, item by item breakdown of the cost of the Great Creek project as described in this report. The project cost, assuming a bid date of December 1984, is estimated at $716,995. A description of the work or materials involved in each line item is also shown.

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Dept. of Environmental Protection
Planning & Coord./Coastal Mngmt.

FLOOD CONTROL - GREAT CREEK
SILVER SANDS STATE PARK
MILFORD, CONNECTICUT
PROJECT BI-T-238C

COST ESTIMATE
BASIC STAGE

APRIL 1984

April 18, 1984

COST ESTIMATE

Item No.	Description	Unit	Estimated Quantity	Unit Price	Extended Total
1	Mobilization and Demobil- ization	LS	LS	LS	$ 7,800.
2	Construction Staking	LS	LS	$6500.00	6,500.
3	Maintenance and Protection of Traffic	LS	LS	LS	2,000.
4	Uniformed Police	HR	160	17.00 HR	2,720.
5	Test Pits	EA	7	210.00 EA	1,470.
6	Erosion Control	LF	250	2.20 L.F.	550.
7	Dewatering and Trench Protection	LS	LS	LS	19,500.
8	Clearing and Grubbing	Acre	7.6	100.00	760.
9	Cut Bituminous Pavement	LF	60	1.00 L.F.	60.
10	Saw Cut Side Walk	LF	10	1.00 L.F.	10.
11	Removal of Bitum- inous Pavement	SF	660	.50 S.F.	330.
12	Excavation	CY	23567	4.25 C.Y.	100,160.
13	Utility Relocation	LS		LS	45,000.
14	Concrete Encase- ment	CY	3.5	250	875.
15	Concrete for Structures	CY	178	213.31	37,970.

Item No.	Description	Unit	Estimated Quantity	Unit Price	Extende Total
16	Crushed Stone Bedding	CY	879	13.00 CY	11,427
17	16' x 5' Box Culvert	LF	260	550. LF	143,000
18	Rip Rap	SY	270	25.00 SY	6,750
19	Chain Link Fence	LF	210	15. L.F.	3,150
20	Special Gravel Fill	CY	270	7.50 C.Y.	2,025
21	Reset Valve Box	EA	2	30.00 EA	60
22	Gravel Subbase	SY	200	.75 S.Y.	150
23	Calcium Chloride	Ton	0.5	300. Ton	150
24	Bituminous Concrete	Ton	70	40.00	2,800
25	Bitimunous Concrete Lip Curb	LF	110	1.50 L.F.	165
26	Concrete Walk	SF	300	3.00 S.F.	900
27	Topsoil, Fertilize, Seed, Mulch and Lime	SY	804	2.00 S.Y.	1,608
28	Bitimunous Concrete Driveway	SF	45	15.00 S.F.	675
29	Reset Manhole or Catch Basin	EA	2	250.00 EA	500
30	Filling in Existing Channel	CY	5603	3.00 CY	16,809
31	Planting	EA	43	40.00 EA	1,720
32	Metal Manhole Steps	Rungs	57	15.00	855
33	Aluminum Railing	FT	254	26.00	6,604
34	Safety Chains	EA	5	50.00	250
35	Aluminum Grating	LS	LS	LS	5,753
36	Grab Bar	EA	2	100.	200

Item No.	Description	Unit	Estimated Quantity	Unit Price	Extended Total
37	Sluice Gates	EA	2	19500.	39,000.
38	Flap Gate	EA	4	5625.	22,500.
39	Steinke Tide Gat	EA	2	27000.	54,000.
40	Site Lighting	LS	LS	LS	2,645.
41	Timber Outlet Channel	LS	LS	LS	99,090.
42	Reconstruct Catch Basins	EA	4	250. EA	1,000.
43	24" R.C.P.	LF	270	26.00 LF	7,020.
44	Removal of Head-wall	EA	1	250.00 EA	250.
45	Remove Existinq Drainage	LF	32	26.00 LF	832.
46	Plug Pipe	EA	4	50.00 EA	200.
				TOTAL	657,793.
				5% Contingency	32,890.
				4% Escalation for December Bidding	26,312.
					716,995.

*12 This item does not include the disposal of excess excavated material, the disposition of which will be decided upon by the State of Connecticut.

Attached to this cost estimate are the outline specifications which correspond to the items in the cost estimate.

GREAT CREEK OUTLINE SPECIFICATIONS

1. Mobilization and Demobilization

All work necessary for the movement of personnel and equipment to and from the project site, and for establishment and removal of all contractor's field offices, buildings and other facilities necessary to the performance of work.

2. Construction Staking

The Contractor shall provide and maintain for the periods needed, reference stakes at one hundred (100') foot intervals outside of the slope limits. Stakes shall be properly marked. Additional stakes to be placed for construction of culverts, gate vault and timber open channel as required.

3. Maintenance and Protection of Traffic

The Contractor shall keep all existing highways and sidewalks opened to vehicular and pedestrian traffic according to the standards for control and protection of traffic on construction and maintenance projects within the public right-of-way. The Contractor shall furnish, erect, light and maintain such signs, barricades and warning lights as needed or directed.

4. Uniformed Police

The Contractor shall furnish uniformed police to act as trafficmen at all locations that proper officials may deem necessary.

5. Test Pits

It may be necessary for the Engineer or Contractor to locate or examine soils, ground water, drains, pipes, rocks, public or private utilities or other obstacles. This work shall consist of the satisfactory removal of all materials, including water within the limits of the test pit. This work shall be done as shown on the drawings or where directed by the Engineer.

6. Erosion Control

Special care shall be taken to prevent contamination or muddying up or interfering in any way of the stream flow along the line of work. Mo waste matter of any kind will be allowed to discharge into the stream flow or impounded wastes of any ponds or other bodies of water. Staked, baled hay shall be installed per the standards of the Erosion and Sediment Control Handbook-Connecticut by the United States Department of Agriculture.

7. Dewatering and Trench Protection

The Contractor shall provide all necessary pumps, dams, drains. ditches, flumes, well points and other means of excluding and removing water from trenches, or other parts of work and for preventing slopes from sliding or caving.

8. Clearing and Grubbing

This work shall consist of clearing the land within the limits of construction and appurtenant designated areas which are part of the contract, of trees, bushes, iron railings, iron posts, stone walls, rubbish and objectional materials as indicated or directed. This work shall also include the cleaning of the site upon completion of all work.

9. Cut Bituminous Pavement

This item shall consist of cutting all bituminous pavement including streets, driveways, sidewalks and curbs to be removed as specified on the plans or as directed by the Engineer.

10. Saw Cut Sidewalks

This item shall consist of cutting all concrete as specified on the plans or as directed by the Engineer.

11. Removal of Butuminous Pavement, Concrete, Asphalt Curbs

This item shall consist of removing all bituminous pavement, driveways, curbs and sidewalks as specified on the plans or as directed by the Engineer.

12. Excavation for Structures and New Channel

This work shall consist of the removal and disposal of all materials necessary for the construction of structures and channel including dredging, backfilling, compacting the backfill and cleaning up the site. This work shall include all necessary clearing, grubbing and removing old structures or parts thereof as required, except where the contract includes a separate item or items for such work.

13. Utility Relocation

The Contractor's attention is called to the fact that he is obligated to inform all utility companies of his startig date on each of the phases of work. Any delays caused due to conflicts with the utility lines shall not be considered as a basis of extending the time for completion. All utilities shall be located and precautions taken to avoid said utilities before commencing excavation. The Contractor assumes all responsibility for damage to the various utility services and all liabilities arising therefrom.

14. Concrete Encasement

Concrete encasement shall be constructed as indicated in the contract plans or as directed by the Engineer of Class "A" concrete.

15. Concrete for Structures

Cement concrete masonry for culverts, headwalls and wingwalls, encasement, gate vault and other work shall be constructed to the designs and dimensions indicated on the plans and to the lines and grades established by the Engineer with or without reinforcement as required.

a) 4000# ready mix
b) 6000# rebars

16. Crushed Stone Bedding

The Contractor shall furnish and place crushed stone for bedding as specified on the plans.

17. Install New 16' x 5' Precast, Reinforced, Concrete Box Culvert

This item includes the furnishing and installation of a precast reinforced concrete box culvert as indicated on the drawings. Included in this item is damproofing the exterior surfaces of the culvert walls, the furnishing and installing of headwall sections and openings in the box culvert of the type and size shown on the contract drawings. Membrane waterproofing to the top exterior surface of the culvert shall also be included in this item.

18. Rip Rap

Rip rap shall consist of heavy stones used to protect foundations and to prevent erosion of embankments placed two (2) feet thick.

19. Chain Link Fence

Furnishing and installing chain link fence at the locations and to the heights shown on the contract drawings.

20. Special Gravel Fill

This material shall be used to replace unsuitable foundation material and elsewhere as indicated on the plans or as ordered by the Engineer.

21. Resetting Valve Box to Grade

This item shall consist of the resetting to grade of all valve boxes as specified on the plans or as directed by the Engineer.

22. Ten (10) Inch Thick Gravel Subbase for Roadway

Work under this item shall be the construction of a subbase for highways, roads, streets, etc., consisting of gravel on the prepared subgrade conforming to the lines and grades, compacted thickness and types of cross-sections as shown on the contract drawings. This item will also include all work necessary for the preparation of subgrade prior to the installation of the subgrade.

23. Calcium Chloride for Dust Control

This work shall consist of furnishing calcium chloride and spreading it on the subgrade or in other areas of the project under construction for the purpose of allaying dust conditions.

24. Bituminous Concrete

Six (6) inch coarse bituminous concrete laid in four (4) courses of equal depth on ten (10) inch calcium chloride compacted, stabilized base of gravel.

25. Bituminous Concrete Lip Curbing

Lip curbing shall consist of machine laid bituminous concrete, constructed on pavement to the dimensions and details shown on the plans or as ordered by the Engineer.

26. Concrete Walk

This item shall consist of concrete sidewalks either replacement or new constructed on a gravel base in the locations and to the dimensions and details shown, including handicapped ramps.

27. Furnish, Place Topsoil, Fertilize, Seed, Milch and Liming and Washout Repair

Furnish all necessary plants, materials, equipment, supplies in connection with filling, loaming, fertilizing and seeding in order to repair washouts as shown in the contract drawings or as directed by the Engineer.

28. Bituminous Concrete Driveway

This item shall consist of construction of an eight (8) inch subbase below three (3) inches of bituminous concrete construction in two (2) equal courses to the details, lines, grades and compacted thickness of the typical driveway cross-section.

29. Reset Manhole or Catch Basins to Grade

This item shall consist of the resetting to grade of all manholes or catch basins specified on the plans or as directed by the Engineer.

30. Filling in of Existing Channel

This item shall consist of the scraping, stockpiling and placement of previously excavated material to the locations, grades and lines shown on the contract drawings or as specified by the Engineer. This work will also include the creating of a swale to accept the road drainage from East Broadway and direct it into the new proposed channel.

31. Planting

This work shall consist of furnishing and planting trees, shrubs and ground cover of the types and in the locations indicated on the landscape or site plans of the contract drawings.

32. Metal Manhole Steps

Extended Aluminum with step portion at least sixteen (16) inches wide (Neenah Foundry R-1982-W).

33. Aluminum Railing

To be 6063 aluminum 1 1/2" rails, 1 1/4" posts with RI-204 anodized finish.

34. Safety Chain

Use Campbell #4/0 straight link-steel. Use anchor shackle on fixed and closed eye swivel on operating end.

35. Aluminum Grating

Grating to be aluminum with abrasive surface to carry a minimum uniform load of 875 psf. Without deflecting more than 1/4" in a four (4) foot span.

36. Side Rail Grab Bar

Same as aluminum hand railing (a special).

37. Sluice Gates

Two (2) gates, each to be 72" wide by 54" high, capable of flush bottom closure. Gates to be cast iron, bronze trimmed, side wedges, stainless steel stem, floor mounted gear operator. Maximum seating head of eleven (11) feet, maximum unseating head of six (6) feet. Gates to be in a tidal environment. Eighteen (18) inch wall thimbles.

38. Flap Gates

Four (4) gates, each to be thirty (30) inches wide by thirty (30) inches high. Gates to be wall mounted, utilizing twelve (12) inch wall thimbles. Gates to be cast iron and trimmed for a tidal environment. Provide fifteen (15) feet of operation chain for each gate.

39. Steinke Tide Gates

Two (2) gates, each to cover an operating 72" wide by 54" high. Gates to be mounted at end of 6' by 4 1/2' by 10" long precast box culvert.

40. Side Lighting

One (1) twenty (20) foot aluminum pole, one (1) 400 watt mercury vapor light. Mount on 18" thick concrete wall between the sluice gates. Power to come from East Broadway.

41. TIMBER OUTLET CHANNEL

The Contractor shall construct the timber outlet channel in conformance with the lines, grades, dimensions, materials and details as shown on the Contract drawings and in compliance with these Specifications. Included in the work is grading, excavation and removal of material to the proposed grades.

Material for timber piles shall comply with the requirements of Section M.09.02-2 of "D.O.T. For 812, 1980, except for minimum diameter dimensions which shall be 12 inches butt and 8 inches tip. Material for timber sheet piling shall comply with Section

M.09.01-1 of "D.O.T. Form 812, 1980". Time sheet piling shall be treated with wood preservatives in the same manner as required for timber piles. Splicing of sheet piling will not be allowed. Wales shall conform to the requirements for timber sheet piling and shall be treated with wood preservatives as required for timber piles.

Timber piles and timber sheet piling shall be driven in compliance with the applicable parts of Section 7.02 of "D.O.T. Form 812, 1980" and to the requirements of the Contract Documents. Water jets may be allowed to obtain satisfactory penetration when specifically authorized by the Engineer. All jetted piles shall be seated by final driving as directed by the Engineer. Suitable excavated material shall be stockpiled on the east side of the construction area as directed by the Owner. Unsuitable excavated material will be deposited in the fill area.

42. <u>Reconstruct Catch Basins or Manholes</u>

Reconstruction of catch basins and manholes as specified on the plans or by the Engineer.

43. <u>24 Inch R.C.P. Storm Drain</u>

Provide and install 24" R.C.P. Class IV to the lines and grades shown on the plans or as specified.

44. <u>Remove Headwall</u>

This item shall include the excavation and removal of an existing headwall shown on the plans and the removal of the debris to an area outside the construction limits suitable for disposal of this material.

45. <u>Remove Existing Drainage</u>

This item shall consist of the removasl and propert disposal of all drainage pipes as specified on the plans or as directed.

46. <u>Plug Pipe</u>

This item shall include the use of brick and mortar to seal the drainage pipes designated on the plans or as directed.

NEW HAVEN REGISTER, THURSDAY, AUGUST 18, 1983

Redirection of creek urged in report on flood control

By PAUL JACKSON
Milford Bureau Chief

MILFORD — Redirecting Great Creek westerly is one recommendation of a $501,300 flood control plan advised in a final draft report just received by the city's Engineering Department.

The report, which Public Works Director John Donnelly emphasized is in preliminary discussion stages, was researched by the Diversified Technology Corp. of North Haven beginning last March when the state Bureau of Public Works authorized the $37,000-plus contract.

The recommended predesign plan also includes making an outlet for the creek into Long Island Sound immediately east of the service road there; channeling; pre-cast concrete box culverts; tide gates; manually operated sluice gates; and an exit channel to the Sound, constructed of timber piles and wood sheeting.

Great Creek, situated in the Silver Sands neighborhood, routinely floods during even minor rainstorms. Neighbors have complained for years that the flooding destroys their property and poses a threat to their lives. Currently, the watershed area encompasses 505 acres but will expand to 538 acres when the Silver Sands landfill is closed.

The final draft said the recommended solution "would provide adequate drainage, thus alleviating the existing flooding problems thus resulting in numerous associated benefits."

City Engineer John Casey, though familiar with the blueprints provided by the consulting firm, said Wednesday that he had not yet read the final draft report.

On the negative side, the report concedes that "on a short-term basis, the major concern (to the recommended plan) would be sedimentation and turbidity entering Long Island Sound during the construction phase."

The weighty draft continues: "Creeks and channels will be altered under this alternative, with the existing channel to the outlet abandoned and filled and a new channel constructed.

"Property improvements can be expected in this area when the threat of flooding is minimized. With the improvements, a rise in property values can also be expected," according to the draft.

The proposed plan might also "greatly enhance" the chance of restoring nearly 105 acres of the drainage basin to a productive salt marsh. The material removed from the basin could be used to cover the landfill, "resulting in savings of significant amount of dollars," the report said.

During the past legislative session, the city received a commitment that the state would overlay and seed the landfill and finance construction of any flood controls that are ultimately approved. Thus, any savings would be to the state, not Milford.

The recommended improvements represent only one of 10 packages discussed in the report. One package had a price tag of $1,232,100, though estimates are not provided for every alternative. Half of them would require ringing part of the area with a dike.

Besides flooding, the Diversified Technology report makes five environmental points based on an investigation of the creek and state park.

- The area previously supported a salt marsh but has been "degraded" by "human alteration of normal drainage patterns." The current condition poses a "significant" fire hazard and the area could become a mosquito breeding ground.

- Even though the salt marsh has deteriorated, the proposed flood work presents an opportunity "for combining flood alleviation with environmental improvements."

The marsh, then, could be returned to its former condition.

- If the goal of the drainage project is to restore the saltmarsh vegetation, the removal of sediment is a key.

- Plans to redirect the flow of water entering Great Creek near Wayland Road might consider "the apparent toxicity" of that water.

- The freshwater wetlands support a "high plant species diversity, including many species of value to wildlife, and harbor many birds. They represent habitat diversity that should be maintained."

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

NOTICE OF MEETING
GREAT CREEK FLOOD CONTROL PROJECT
MILFORD, CONNECTICUT

Great Creek, in Milford, is in need of remedial work to reduce damage in the area from flooding during storms. The Dept. of Environmental Protection has been requested to study causes of flood flows and to provide alternatives for reducing damage from such flows.

Accordingly, an informational meeting will be held on Wednesday, September 21, 1983, in Old Central Grammar School, 1 Polizzi Plaza, Milford, starting at 7:30 p.m..

At this meeting, Department staff will present the problem and discuss possible solutions.

All interested persons are invited to participate in this meeting. Prior to the meeting, any inquiries should be directed to Mr. Arba A. Roberts, Assistant Director, Water Resources Unit, at 203-566-7244.

Dated: September 6, 1983

Stanley J. Pac

Stanley J. Pac, Commissioner

Phone:
165 Capitol Avenue • Hartford, Connecticut 06106

BRIDGEPORT POST, Thursday, September 22, 1983

DEP official to push rechannel plan

By CATHERINE CLABBY
Post staff writer

MILFORD — The state official overseeing design research of Great Creek flood control proposals will recommend that the Department of Environmental Protection pursue a $501,300 plan that would rechannel the creek to the west.

Benjamin Warner, director of DEP's Water Resources Division, said Wednesday he will ask DEP Commissioner Stanley Pac to accept the rechanneling plan and pursue funding for final design work from the state Department of Public Works. Construction may not begin until next fall.

Warner made his comments following a public hearing on the issue attended by more than 35 Silver Sands area residents, city and state officials and representatives from Diversified Technology Corps., a North Haven-based engineering firm.

"I consider the response of the people to be an affirmative one," said Warner, who told residents early in his presentation that his department favored the rechanneling plan over other proposals prepared by Diversified Technology Corp.

"It seems to us to offer the best solution under the circumstances," said Warner, who added that the plan will not eliminate all flooding in the area, which has an extremely low elevation, but will provide quick drainage where there now is nearly none.

Other alternatives included a plan to repair and expand an existing outlet near Blair Street and the taking of some private property, the construction of a system of dikes and the installation of a stormwater pumping station.

Warner decided on his recommendation after taking an informal vote among audience members on their opinions. The advantages of the plan, he said, are that it is compatible with pending state projects at Silver Sands State Park, its cost is relatively low and all construction could be limited to state property.

Final design of the project probably will take three months, according to a Morgan Ely, chief of the Design and Review division of the state Department of Public Works, who also attended the meeting. Ely said he does not expect construction will begin on the project until next fall.

State Rep. Timothy Casey, R-Milford, however, said he has had some indication for Public Works officials that if the application process goes smoothly, construction could begin as early as next spring.

Various state and federal permits must be secured for the work, which is expected to restore 100 acres of salt marsh in the area.

The project will be funded with part of the $6.5 million the state Legislature has earmarked for a flood-control project in the area as well as the closing and capping of a landfill on Silver Sands State Park property.

The plan calls for the use of dredge material from the rechanneling effort to be used to cap the landfill. In addition, an improved flow of water is expected to eliminate the stagnant pools in the residential area that last summer turned into an extensive breeding ground for mosquitoes.

The plan, estimated to cost $501,300, would connect the east and west branches of the creek and rechannel it to the west, east of a service road on Silver Sands State Park property. Included would be the installation of two tide gates, three sluice gates, a 310-foot-long enclosed concrete culvert and a 180-foot raised lumber channel, 15 to 25 feet wide.

The state would abandon a culvert already exising off of Blair Street.

Silver Sands Homeowners' Association President William Ziebell told state officials he would have preferred an open channel rather than an enlosed culvert at the base of the rechanneled creek, as it would serve as a boundry between his neighborhood and the state park. But Don Ballou, a Diversified engineer, said an open channel would be impractical because it would be easily clogged with sand and could limit access to the beach, which is open to all below the high tide mark.

DEP: flood control plan will speed landfill cap

MILFORD — Progress toward implementing a flood control project in the Great Creek area will accelerate action on capping a landfill at Silver Sands State Park, according to a Department of Environmental Protection official.

"As soon as this one (the flood-control project) is squared away, we can proceed with the landfill closure," said Richard Clifford, assistant director of state parks and recreation.

The landfill, used by the city at present to dump treated sludge from its sewage treatment plant, is slated to be closed and capped after a flood-control project is underway, Clifford said today.

He said final design work for the landfill closure, completed two years ago, will require some updating. That work, which could be completed by the state Department of Public Works or a private contractor, would begin after final design work on the flood-control project is completed.

Final design work on the proposed $501,300 Great Creek project is expected to take three months, according to engineers from the North Haven-based Diversified Technology Corp. who completed the intial design work.

The only thing that could slow the project, according to Clifford, are insufficient funds for both the Great Creek proposal and the landfill closure.

The state Legislature has appropriated $6.5 million for both projects. Clifford said further funding would be sought from existing bonds authorizations if the projects exceed that amount. - CATHERINE CLABBY

Drain Plan Set For Great Creek

Citizen Staff Reporter

A $501,300 drainage system will be used to check the Great Creek flooding of streets and homes in the East Broadway area, Director Benjamin Warner of the Water Resources Unit of the state Department of Environmental Protection (DEP) announced as 35 residents assembled for a public hearing he conducted in the old Central Grammar School Wednesday night.

Designed by Diversified Technologies Corp. of North Haven, the plan provides for redirecting the creek to the west with a new 40-foot channel; a new culvert and outlet to Long Island Sound near the service road going into the Silver Sands State Park area; and tide and sluice gates.

Other alternatives, providing for diking and pumping stations and costing up to $1.2 million, were discussed but will not be used.

More Discussion Planned

Warner authorized Diversified Technologies to proceed with preparation of final plans and specifications that will be needed for bidding and award of a contract for the work. Warner said another public hearing, for more discussion of the final plan, will be scheduled before the project gets underway next year.

He said the plan DEP has designated as the one to be used "is the most feasible." He described it as "the most practical solution to the problem." Apparently referring to the park development, he said it has "advantages to other future projects."

Although this will eliminate the flooding the East Broadway area has been getting three to four times every year, Warner said, "It will still be subject to flooding in a very heavy tidal storm." DEP engineer Arthur Christian said, "There would be a chance every 10 years of it flooding over East Broadway." Donald Ballou of Diversified Technologies added, however, the later will flow out in three hours as contrasted with the present stagnation for many days.

Flow increase Projected

Dr. Murali Atluru, president of Diversified Technologies, said the new outlet will allow a flow five times greater than the present outlet between Blair and Tremont Streets. He said the plan his firm has developed "will provide good flushing to eliminate water stagnating." Dr. Atluru said he found an 1838 map that showed a 270-acre salt marsh that's now been diminshed to 100 acres.

Dr. Karl Tolonen, also of Diversified Technologies, said, "There will be an environmental improvement. One hundred acres will revert to the type of salt marsh that was there 100 years ago."

DEP engineer Philip Moreschi said the plan DEP has chosen "will require no property taking." He said other plans that had been considered "meant taking homes."

Resident Input

City Engineer John Casey said he endorsed the plan DEP has chosen, with one exception. "I'm concerned about the closing of the existing channel," Casey said. The city engineer said he would favor "leaving the existing outlet in addition to the new outlet."

Warner said that and other suggestions advanced by the residents attending the hearing will be considered in the preparation of the final plan.